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# Bulletin of Duke University

School of Forestry  
and Environmental Studies

1977-1978





# Bulletin of Duke University

School of Forestry  
and  
Environmental Studies

1977-1978

Durham, North Carolina 1976



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Duke University Bulletins Office

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Elizabeth Matheson

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# University Administration

## GENERAL ADMINISTRATION

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J. Peyton Fuller, A.B., *Assistant Vice President and Controller*  
Harold W. Lewis, Ph.D., *Vice Provost and Dean of Faculty*  
John C. McKinney, Ph.D., *Vice Provost and Dean of the Graduate School*  
John M. Fein, Ph.D., *Vice Provost and Dean of Trinity College of Arts and Sciences*  
Ewald W. Busse, M.D. *Associate Provost and Dean of Medical and Allied Health Education, School of Medicine*  
Roscoe R. Robinson, M.D., *Associate Vice-President for Health Affairs and Chief Executive Officer of Duke Hospitals*  
Frederick C. Joerg, M.B.A., *Assistant Provost for Academic Administration*  
Anne Flowers, Ed.D., *Assistant Provost for Educational Program Development*  
William J. Griffith, A.B., *Assistant Provost and Dean of Student Affairs*  
William C. Turner, Jr., M.Div., *Assistant Provost and Dean of Black Affairs*  
Richard L. Wells, Ph.D., *Assistant Provost and Associate Dean of Trinity College of Arts and Sciences*  
Joel L. Fleishman, LL.M., *Vice Chancellor for Public Policy Education and Research; Director of Institute for Policy Sciences and Public Affairs*  
Connie R. Dunlap, A.M.L.S., *Librarian*  
William E. King, Ph.D., *University Archivist*  
Clark R. Cahow, Ph.D., *University Registrar*  
Robert N. Sawyer, Ed.D., *University Educational Planning Officer and Director of Summer Educational Programs*  
Rufus H. Powell, LL.B., *Secretary of the University*  
Charles Linn Haslam, J.D., *University Counsel*

## SCHOOL OF FORESTRY AND ENVIRONMENTAL STUDIES ADMINISTRATION

Benjamin A. Jayne, M.F., Ph.D., *Dean of the School of Forestry and Environmental Studies*  
Fred Myerle White, M.F., *Director of the Duke Forest and Assistant to the Dean*  
Robert Lloyd Barnes, M.F., Ph.D., *Director of Admissions*  
Roger Fabian Anderson, M.S., Ph.D., *Director of Graduate Studies in the Department of Forestry and Environmental Studies of the Graduate School*

## School of Forestry and Environmental Studies Faculty and Staff

Roger Fabian Anderson (1951), M.S., Ph.D., *Professor of Forest Entomology*  
Robert Lloyd Barnes (1965), M.F., Ph.D., *Professor of Forest Biochemistry*  
Frank J. Convery (1971), M.S., Ph.D., *Associate Professor of Natural Resources Economics*  
Jarir S. Dajani (1971), Ph.D., *Assistant Professor of Environmental Studies*  
Henry Hellmers (1965), Ph.D., *Professor of Botany*  
Benjamin A. Jayne (1976), M.F., Ph.D., *Professor of Forestry*  
Frederick Charles Joerg (1947), M.B.A., *Professor of Forest Management*  
Kenneth Richard Knoerr (1961), M.F., Ph.D., *Professor of Forest Meteorology*  
Jane Philpott (1951), Ph.D., *Professor of Botany and Professor of Wood Anatomy*  
R. Rajagopal (1974), M.E., Ph.D., *Assistant Professor of Management Science*  
Charles William Ralston (1954), M.F., Ph.D., *Professor of Forest Soils*  
William James Stambaugh (1961), M.S., Ph.D., *Professor of Forest Pathology*  
P. Aarne Vesilind (1970), Ph.D., *Associate Professor of Environmental Studies*  
Fred Myerle White (1959), M.F., *Assistant Professor of Silviculture*  
David Owen Yandle (1967), M.S., Ph.D., *Associate Professor of Forest Mathematics*

## ASSOCIATE FACULTY

Donald J. Fluke, Ph.D., *Professor of Zoology*  
Aubrey W. Naylor, Ph.D., *Professor of Botany*

## ADJUNCT FACULTY

Edgar W. Clark, Ph.D., *Adjunct Associate Professor of Forest Entomology*  
Milton S. Heath, Jr., LL.B., *Adjunct Professor of Environmental Law*  
Charles S. Hodges, Jr., M.F., Ph.D., *Adjunct Associate Professor of Forest Pathology*  
Louis J. Metz, M.F., Ph.D., *Adjunct Associate Professor of Forest Soils*  
Fred M. Vukovich, Ph.D., *Adjunct Associate Professor of Forest Meteorology*

## STAFF

Patricia S. Rorie, *Recorder and Secretary to the Dean*  
E. Otto Griffin, Jr., *Superintendent, Duke Forest*  
Sue P. Hicks, *Secretary, Duke Forest*  
Nancy A. McMannen, *Secretary*  
Jo W. Russell, *Secretary*  
Roberta G. Stavros, *Secretary*  
James E. Boring, *Instrument Technician*  
Ann Dudgeon, *Research Associate*  
Fred L. Mowry, *Research Associate*

## FACULTY EMERITI

Leon Edward Chaiken, M.F., *Professor Emeritus of Forest Management*  
Paul Jackson Kramer, Ph.D., *James B. Duke Professor Emeritus of Botany*  
James Granville Osborne, B.S., *Professor Emeritus of Forest Biometry*  
Albert Edward Wackerman, M.F., *Professor Emeritus of Forest Utilization*



# School of Forestry and Environmental Studies Calendar\*

1977

- June**  
13 Monday—Summer Session classes begin
- August**  
19 Friday—Summer Session classes end  
29-31 Monday-Wednesday—Registration and matriculation of all new and non-registered returning students in the School of Forestry and Environmental Studies
- September**  
6 Tuesday—Fall semester classes begin  
7 Wednesday—Drop/Add begins, 4:00-6:00 p.m., Indoor Stadium
- October**  
24-27 Monday-Thursday—Registration for Spring Semester, 1978
- November**  
23 Wednesday—Thanksgiving recess begins at 6:00 p.m.  
28 Monday—Classes resume
- December**  
7 Wednesday—Fall semester classes end  
8-13 Thursday-Tuesday—Graduate reading period  
15 Thursday—Final examinations begin  
22 Thursday—Final examinations end

1978

- January**  
6 Friday—Registration and matriculation of all new and non-registered returning students in the School of Forestry and Environmental Studies  
9 Monday—Spring semester classes begin  
10 Tuesday—Drop/Add begins, 4:00-6:00 p.m., Indoor Stadium
- March**  
3 Friday—Spring recess begins, 6:00 p.m.  
13 Monday—Classes resume  
27-29 Monday-Wednesday—Registration for Fall Semester, 1978 and Summer, 1978
- April**  
17 Monday—Spring semester classes end  
18-24 Tuesday-Monday—Graduate reading period  
25 Tuesday—Final examinations begin
- May**  
1 Monday—Final examinations end  
6 Saturday—Commencement begins  
7 Sunday—Graduation exercises

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\*Due to publication date, items in the Calendar are subject to change.





# General Information







## Duke and the School of Forestry and Environmental Studies

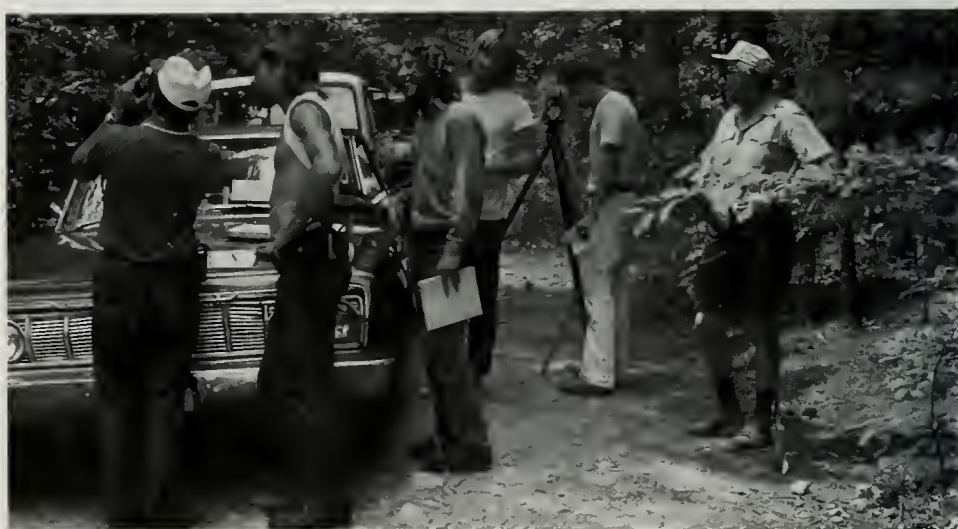
Duke University, located at Durham, North Carolina, comprises Trinity College of Arts and Sciences, the School of Engineering, the Graduate School, and the professional schools of Forestry and Environmental Studies, Divinity, Law, Medicine, Business Administration, and Nursing. The University dates from 1838, when Union Institute was founded in Randolph County by the Methodists and Friends. In 1851 the institution became Normal College, one of the first schools in America for the training of teachers. In 1859 the name was changed to Trinity College by which it was known for sixty-five years.

On December 11, 1924, James Buchanan Duke executed the Indenture of Trust that provided for hospitalization, church work in rural communities, and education. The principal feature of the educational provision was the creation of Duke University.

Now, the University, with a student body totaling 9,000, occupies two campuses. The East Campus of 108 acres was formerly the campus of Trinity College. About a mile west are the newer units of the University, known as the West Campus, totaling 467 acres. It was first occupied in September, 1930.

Forestry at Duke University began early in 1931 when the Duke Forest was placed under intensive forest management and forestry research was initiated. An academic-forestry curriculum, designed for men and women intent upon pursuing forestry as a profession, was organized in Trinity College of Duke University in 1932. This program was enlarged in 1952 and now includes more than sixty cooperating colleges and universities. (See pages 18-19).

In 1938 the School of Forestry was organized at the graduate level and a curriculum was offered leading to the degree of Master of Forestry. Work leading to the degree of Doctor of Forestry has been offered since 1940. In 1969 the School began responding to demands for individuals with professional expertise in environmental management by developing curricula in this growing field. Graduates of these programs have been awarded the Master of Environmental Management degree since 1975. The School has been fully accredited since its origin.



A degree in forestry or environmental studies at the undergraduate level is not offered at Duke University.

Graduates of recognized colleges, universities, professional schools of forestry, and other students who meet the entrance requirements of the School (see page 21) may enroll in forestry programs leading to the professional degrees of Master of Forestry, Master of Environmental Management, and Doctor of Forestry. The Department of Forestry and Environmental Studies in the Graduate School also offers graduate work in certain aspects of forestry leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy. This work is available to graduates of schools of forestry of recognized standing and to college or university graduates holding a bachelor's degree. All applicants will be considered without regard to race, color, religion, sex, or national origin.



### **Policy of Nondiscrimination**

Duke University does not discriminate on the basis of race, color, national and ethnic origin, or sex, in the administration of educational policies, admission policies, financial aid, employment, or any other university program or activity. It admits qualified students of any race, color, national and ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students.



# Program Information





## Fields of Study

Basic scientific or professional programs of study are available in the following fields of forestry and related natural resources. Interdisciplinary programs between fields within the School of Forestry and Environmental Studies and those in other departments of the University are strongly encouraged.

### Biological Science

Forest Ecology  
Tree Physiology and Biochemistry  
Forest Pathology  
Forest Entomology  
Dendrology and Wood Anatomy

### Statistics and Operations Research

Biometry and Statistics  
Mensuration  
Operations Research

### Environmental Science

Forest Soils  
Forest Meteorology and  
Biometeorology  
Wildland Hydrology

### Economics and Management

Natural Resources Economics and  
Policy  
Environmental Management  
Forest Management

With the exception of forest management, study in all of the above fields can be pursued in programs for a M.S., A.M., or Ph.D. degree in the Department of Forestry and Environmental Studies of the Graduate School, or in a professional program for a M.F., M.E.M., or D.F. degree from the School of Forestry and Environmental Studies. Students contemplating careers in teaching and research are strongly urged to follow courses of study in the Department of Forestry and Environmental Studies in the Graduate School.

In addition, the following special programs of study leading to the M.F. degree are available in the School of Forestry and Environmental Studies: Post-Liberal Arts and Science Program, Business Management Program, Forest Protection Program, Cooperative Forestry Program, and Natural Resource Ecology and Environmental Management Program for the M.E.M. degree.

Detailed information on these special programs is given under the Master of Forestry Degree, Master of Environmental Management Degree, and the Cooperative Plan of Study section in this *Bulletin*.

# Master of Forestry Degree

The requirements for the degree Master of Forestry (M.F.) are governed by the extent of the student's previous undergraduate education, both in professional and related subjects, and by his specific career objectives. Usually, students who have earned the degree of Bachelor of Science in Forestry, or the equivalent, from an accredited school of forestry may complete the requirements for the M.F. degree in one academic year. Students with no prior preparation in forestry are required to begin their studies with a summer term of ten weeks. Thereafter, four semesters of study are required under this program for attainment of the M.F. degree. Graduate work of equivalent grade done in residence at other institutions may, with the approval of the faculty, be accepted as credit toward the degree, but a minimum of one year of residence at Duke University is required.

A number of courses in other departments of Duke University, the University of North Carolina, and North Carolina State University are open to qualified students of the School of Forestry and Environmental Studies. Such courses may be included in a student's program of study on approval of his adviser or supervisory committee.

If a thesis is required, a student who has not completed the thesis while in residence must submit an acceptable manuscript to the faculty within a period of two years following the termination of residence.

No student may take less than fourteen nor more than eighteen units of credit per semester without special permission of the faculty (see pages 25-27).

**Post Liberal Arts and Science Program.** Men and women who are college graduates but have had no prior professional forestry training may be admitted to programs of study leading to the degree of Master of Forestry. Depending on the program of study, sixty to seventy units of credit in residence are minimal requirements, beginning with the summer session and subsequently including the other courses listed below. In the case of students with advanced preparation equivalent to these specific subjects, total unit credit requirements may be reduced. Such reductions will be approved on an individual basis and only on specific recommendation of the student's major program adviser and approval by the faculty.

## Summer Session

	Units
Careers in Natural Resources (For. 200)	0
Tree Growth and Development (For. 205)	3
Dendrology (For. 241)	3
Forest Measurements (For. 256)	4

## Other Courses

Soils and Forest Resources (For. 261)	3
Natural Resource Ecology (E.S. 243)	3
Resource Economics and Policy (For. 269)	3

On completion of the fall term of the first year, each student will be requested to designate the field (or fields) he wishes to pursue for a major. After the student has designated his field of interest, he will be assigned a faculty adviser who, in consultation with the student, will develop a program of study in a manner similar to that described under the Postprofessional Program (see below).



Any student who does not earn a grade of *E* or *G* in at least six units of work in the first academic year will not be permitted to enter into the work of the second year.

**Postprofessional Program.** Students with satisfactory undergraduate professional training qualify for advanced study and research in the various disciplines of forestry under this program. A specific study plan is developed for each student through consultation with a faculty advisory committee. For the student planning a managerial career in the general area of forest production (and where the Master of Forestry is planned as a terminal degree), his program of study usually consists of courses and seminars, with a major portion of the work concentrated in the area of the student's interests. For the student with interest in research, the study plan is oriented within a specific discipline in order to prepare him for a research career or for academic training beyond the master's level.

A minimum of thirty units, in which the student must earn a grade of *E* or *G* in at least six units, are required for the degree of Master of Forestry under this program. Usually, fifteen units of credit (including the thesis) must be earned in the School of Forestry and Environmental Studies.

**Forest Protection Program.** A combined program of specialization in entomology-pathology is available for students desiring career preparation in the applied aspects of forest insect and disease control. This program of study leads to the Master of Forestry degree. Students electing the program must hold either a bachelor's degree in general forestry or have equivalent preparation in the biological sciences.

The general requirements of the program are as follows:

1. A minimum of twenty-eight units in forest entomology and forest pathology. With approval, credits in closely related disciplines may be substituted.
2. At least twelve units of courses and seminars dealing with managerial and statistical aspects of forest protection.
3. One summer of employment experience with a forest protection agency.
4. Organization, conduct, and report of applied research on forest insects and/or disease problems (four units).

Reasonable latitude will be permitted in selecting courses to accommodate specific needs and interests. Each program of study will be developed in consultation with the program directors. A list of recommended courses is available upon request.

Applicants for this program must meet the requirements of the School of Forestry and Environmental Studies and the approval of the program advisory committee.

## Master of Environmental Management Degree

The requirements for the Master of Environmental Management degree are governed by the extent of the student's previous undergraduate education and by his specific career objectives.

A student without prior education in environmental management will be required to complete the equivalent of four semesters of resident study (sixty units) beyond the baccalaureate degree level, including the core courses given below. Students accepted from the cooperative college program must complete five semesters of resident study (seventy units). Graduate work of equivalent grade done in residence at other institutions may, with approval of the faculty,



be accepted as credit for the degree, but a minimum of one year of residence at Duke University is required.

No student may take less than fourteen or more than eighteen units of credit without special permission of the faculty (see page 27).

### Core Courses\*

	<i>Units</i>
Natural Resource Ecology (E.S. 243)	3
Biometry (For. 250)	3
Computer Science in Natural Resources (For. 253)	3
Soils and Forest Resources (For. 261)	3
Resource Economics and Policy (For. 269)	3
Ecological Principles in Environmental Management (E.S. 341)	3
Environmental Management Seminar (E.S. 347-8) (1 unit per semester)	4
Natural Resource Law and Policy (Plan. 233—UNC)	3

**Natural Resource Ecology and Environmental Management Program.** A professional program is offered to students with career interests in the expanding fields of environmental management and protection. The basic objective of this program is to develop expertise in planning and administering the management of natural resources and the non-urban environment for maximum human benefits with minimum deterioration of ecosystem stability. Emphasis is placed on the ecosystem as the basic unit of natural resource management.

This program of study leads to the Master of Environmental Management degree and is open to students with a bachelor's degree in biological or environmental science or with training in other fields and a strong motivation toward an ecological approach to natural resource problems.

General requirements of the program are:

1. A minimum of twenty-four units in resource ecology and environmental science.
2. At least nine units in courses dealing with statistical or mathematical analysis of natural resource problems.
3. A minimum of fifteen units in courses in resource use planning, business, and public administration.
4. Formulation, analysis, and report of research on an applied problem related to ecological or environmental aspects of natural resource management.

Although all students are expected to have substantive knowledge of principles of resource ecology, environmental science, and quantitative analysis, reasonable latitude is permitted in electing courses to meet the interests and capabilities of individual students. Each program of study will be developed in consultation with the program directors.

## Concurrent Degree Program in Business Management and Forestry or Environmental Management

This sequence is designed for students who wish to attain expertise in forestry or in environmental management and business management. It will normally take three years and some summer course work to complete the program, at which time both the Master of Forestry or the Master of Environmental

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\*Prerequisites: Introductory Biology and Introductory Economics must be completed before entering program or taken without credit after entering program.

Management and a Master of Business Administration will be awarded. The first two years will be devoted primarily to study in the Graduate School of Business Administration while the third year will be spent in the School of Forestry and Environmental Studies. At least one summer will be spent working for a forestry firm. Because of the special intellectual demands involved in mastering two professions, exceptionally high standards will be applied in admitting students, and enrollment in the program will be limited. Students must apply and be accepted for each program individually. For information on the Graduate School of Business Administration, the prospective student should write to: Admissions Office, 127 Social Sciences Building, Graduate School of Business Administration, Duke Station, Durham, North Carolina 27706.

## **Concurrent Degree Program in Policy Sciences and Forestry or Environmental Management**

This sequence is designed for students who wish to attain expertise in forestry or environmental management and policy analysis. It will normally take two and one-half years to complete the program, at which time both the Master of Forestry or the Master of Environmental Management and a Master of Arts in Policy Sciences will be awarded. The first year will be devoted to study in the School of Forestry and Environmental Studies while the second year will be spent in the Institute of Policy Sciences and Public Affairs. The final semester will involve work in both areas. A summer internship in policy sciences is required. Doctoral candidates are also eligible to undertake the Master of Arts in Policy Sciences program. Because of the special intellectual demands involved in mastering two professions, exceptionally high standards will be applied in admitting students, and enrollment in the program will be limited. Students must apply and be accepted for each program individually. For information on the Institute of Policy Sciences and Public Affairs, the prospective student should write to: The Institute of Policy Sciences and Public Affairs, Box 4875, Duke Station, Durham, North Carolina 27706.

## **Program in Tropical Forestry**

Fellowships are available for travel and subsistence in field-oriented programs in Central America. Refer to the section titled Organization for Tropical Studies in the *Graduate School Bulletin* in the chapter Special and Cooperative Programs.

## **Master of Science Degree**

**Prerequisites.** The degree of Master of Science (M.S.) is offered through the Department of Forestry and Environmental Studies in the Graduate School. As a prerequisite to this degree a student must have earned a baccalaureate degree from an accredited college or university. There is no foreign language requirement for this degree.

**Major and Minor Subjects.** The work for the Master of Science degree is designed to provide a basic foundation in a fundamental area of forestry or in a field closely allied with forestry. A minimum of thirty units of credit is required for the degree; twenty-four units must be in formal courses although not more than six units can be earned for the thesis. Specific course requirements call for a minimum of twelve units in a major field of specialization and six units in a minor area of concentration. The major and minor fields are determined without

regard to departmental divisions of the University if the interdisciplinary nature of the area of specialization makes such a program of study advisable. The specific program of study is developed by the major professor (thesis supervisor), subject to the approval of the Director of Graduate Studies in forestry and the Dean of the Graduate School.

**The Thesis.** At least one month before presenting the thesis, that is on or before February 1 or a May degree or on or before August 1 for a September degree, the student must file with the Dean of the Graduate School, on the official form, the title of the thesis and the declaration of intention to graduate. The title must have the approval of the thesis supervisor and the director of graduate studies in the major department. If the student has met the degree requirements before the above deadlines, he must file his intention to graduate one month before the thesis is presented. The basic requirements for preparing the dissertation, regulating such things as type of paper, form, and binding, are prescribed in the *Guide for the Preparation of Theses and Dissertations* which is available in the Graduate School Office, 127 Allen Building.

Four typewritten copies of the thesis, bound in snap binders supplied by the Library, must be submitted through the Graduate School Office to the Dean of the Graduate School on or before April 15 for a May degree or on or before August 15 for a September degree, and at least one week before the scheduled date of the student's examination. The copies will then be distributed by the student to the several members of the examining committee. Three copies for the library will be bound by the Ruzicka Bindery for a fee of \$5 a volume. The student may request that an additional number of copies be so bound.

**The Examining Committee and the Examination.** The instructor who directs the student's program appoints an examining committee composed of himself and two other members of the graduate faculty, one of whom must be from a department other than that of the major. If the student has been permitted to take related work within the major department, the third member may represent the minor field within the department. The names of the members of this committee are submitted for approval to the Dean of the Graduate School at least one week preceding the final examination.

This committee administers the examination and certifies whether the student has passed or failed by signing the card provided for this purpose by the Graduate School Office. This card is used to indicate completion of all requirements for the degree. After a thesis is approved the committee signs all copies of the thesis, and the candidate then returns the original, the first two carbon copies, and any other copies he wishes bound by Ruzicka to the Dean of the Graduate School who deposits them in the University Library.

## Master of Arts Degree

The degree of Master of Arts (A.M.) is offered through the Department of Forestry and Environmental Studies in the Graduate School. As a prerequisite to admission for this program, a student must have earned a baccalaureate degree from an accredited college or university. Students interested in working toward this degree should refer to the *Bulletin of the Graduate School* for specific requirements.

## Doctor of Forestry Degree

The degree of Doctor of Forestry (D.F.) is a professional and research degree conferred upon those students who have satisfactorily completed specified requirements of advanced study and research.





Work toward the D.F. degree, consisting of advanced studies in a major and a minor field, is offered with majors in the several branches of forestry. A minor may be elected in forestry or in other areas of specialized study in the University approved by the faculty of the School of Forestry and Environmental Studies. Prospective students should correspond with the Director of Admissions to the School of Forestry and Environmental Studies on all matters pertaining to admission to the School.

## **Doctor of Philosophy Degree**

The Doctor of Philosophy degree (Ph.D.) is conferred through the Graduate School of Duke University. Programs of study and research for men and women working for this degree are directed by faculty members of the School of Forestry and Environmental Studies who also comprise the graduate faculty of the Department of Forestry and Environmental Studies in the Graduate School. Both major and minor programs of study are available in the following branches of forestry: forest biochemistry, forest biometry, forest meteorology, forest ecology, forest economics, forest entomology, forest hydrology, forest pathology, forest soils, forest-tree physiology, wood anatomy, and wood chemistry.

The Ph.D. degree is essentially a research degree. Although course work is a necessary part of the student's program, the mere accumulation of course credits will not be sufficient for attaining this degree. The granting of the Ph.D. degree is based primarily upon the student's knowledge of a specialized field of study and upon the production of an acceptable dissertation embodying the results of original research.

## General Requirements for the D.F. and Ph.D. Degrees

The formal requirements, discussed in detail below, for the doctoral degrees are as follows: (1) foreign language; (2) major and related courses; (3) supervisory committee for program of study; (4) residence; (5) preliminary examination; (6) dissertation; and (7) final examination. In order to be considered for candidacy for a doctoral degree, the student must have passed all of his course work in the first year of graduate study and have made a grade of C or better on at least nine units of that work.

**Foreign Language Requirements.** A reading knowledge of at least one foreign language is required for the D.F. and Ph.D. degrees. Languages usually taken are French, German, and Russian. Another language which has a definite relation to the degree program and for which an examination can be provided may be substituted for any of these with the approval of the supervisory committee.

A foreign student whose native language is not English may request that the director of graduate studies ask permission of the Dean of the Graduate School to offer English as the foreign language required in his program.

With the special approval of the Dean and of the Executive Committee of the Graduate Faculty, the foreign language requirement for the Ph.D. may be waived in individual cases provided the department submits satisfactory evidence that a foreign language has little bearing on the major program of the student concerned.

The foreign language requirement(s) may be satisfied in the following ways:

1. The student may take the Educational Testing Service examination at one of the many national centers (including the Duke University Counseling Center). To avoid delays, prospective students are urged to take appropriate ETS Graduate School Foreign Language tests prior to registration. However, it should be noted that at the time of the final examination in a master's program or of the preliminary examination in a doctoral program, language certificates more than six calendar years old will not be accepted toward fulfilling the language requirement.

2. In a language for which ETS tests are not available, a reading examination may be arranged by the Graduate School Office and administered by a qualified examiner.

**Special Reading Courses.** Special courses designed to assist graduate students in acquiring a reading knowledge of French or German are offered for three hours a week. French is offered during the fall semester and occasionally in the spring, and German during the spring semester and the summer session. A student who registers for either course must reduce his normal load of graduate courses by three units, with no reduction in fees. No auditors are permitted in these courses at any time. Undergraduates may not enroll during the academic year but may register, with permission of the Dean of the Graduate School, in the summer session if total registration permits.

**Major and Related Work.** The student's program of study necessarily demands substantial concentration on courses in his major department. It must, however, include a minimum of six units in related fields approved by his major department. Use of related fields within the major department requires the approval of the Dean.

**Committee to Supervise the Program of Study.** As early in a student's course of study as is practicable and *not later than two months before the prelimi-*

*nary examination*, the director of graduate studies in the major department will nominate for the approval of the Dean a supervising committee of five, with one member designated as chairman. This committee will include at least three members of the major department and one from the minor department, if a minor is involved. This committee will approve the program of study, as well as administer the preliminary examination and the final doctoral examination. Should all members of the committee be from the major department, at least one member of another department will be added or substituted for the final doctoral examination. The final examination may be administered with a minimum of four members.

When the preliminary examination is arranged, the committee and the director will submit to the Dean the student's program of study bearing a state-





ment that the department's course and language requirements have been, or are being, completed.

**Residence.** The *minimum* registration requirement is sixty units of graduate credit, not more than thirty units of which may be accepted by transfer. Since a full program is thirty units per academic year, the prospective doctoral candidate who enters with an A.B. or B.S. degree must plan to spend in residence a *minimum* of two academic years; if he enters with an A.M., M.S., or M.F. degree, his *minimum* residence is one academic year. If there are undergraduate deficiencies in his program, he may, in addition to the minimum requirements, be required to take preliminary undergraduate courses for which he will not receive graduate credit. Even if there are no such undergraduate deficiencies, the student's supervisory committee will determine what requirements, if any, above the minimum the student must meet. See pages 25-27 for further information on registration in residence and *in absentia*.

When the preliminary examination is passed, any courses, language certifications, or other credits for advanced standing which are more than six calendar years old will not be accepted toward fulfilling the minimum requirements of the doctoral degree.

Usually the student should pass the preliminary examination by the end of his second year of graduate study. If he has not passed it by the middle of the third year, he must file with the Dean a statement explaining the delay, and setting a date for the examination. Except under unusual circumstances, extension will not be granted beyond the end of the third year.

The doctoral dissertation should be submitted and accepted within two calendar years after the preliminary examination is passed. Should the dissertation not be submitted and accepted within four years after the examination, the candidate, with the approval of his committee, may petition the Dean for an extension of one year. Should this extension be granted and the dissertation not be submitted and accepted within the year, the student must pass a second preliminary examination to remain a doctoral degree candidate. In such a case, the time limit for submitting the dissertation will be determined by the Dean and the candidate's committee.

**Preliminary Examination.** A student is not accepted as a candidate for the doctoral degree until he has passed the preliminary examination. A transfer student who may have passed a preliminary examination elsewhere must, nevertheless, take the examination at Duke. The examination ordinarily covers both the major and minor fields.

In the summer, a preliminary examination may be scheduled only between the opening and closing dates of the summer session.

Should the student fail the preliminary examination, he may apply, with the consent of his supervisory committee and the Dean, for the privilege of a second examination to be taken no sooner than three months after the date of the first. Failure on the second examination will render the student ineligible to continue his program for the doctoral degree at Duke University.

**The Dissertation.** The dissertation is expected to be a mature and competent piece of writing, embodying the results of significant and original research.

Not later than February 1 (February 2, if February 1 falls on Sunday) preceding the May commencement at which the degree is expected to be conferred, the student must file with the dean of the appropriate school, on the official form to be obtained from the Graduate School Office, the title of the dissertation. This title must receive the written approval of both the director of graduate studies of the student's major department and the professor who directs the dissertation. The basic requirements for preparing the dissertation, regulating such



things as type of paper, form, and binding, are prescribed in the *Guide for the Preparation of Theses and Dissertations* which is available in the Graduate School Office, 127 Allen Building.

The dissertation must be completed to the satisfaction of the instructor who directs it. Four typewritten copies bound in snap binders secured through the Graduate School Office must be deposited with the dean of the appropriate school on or before April 1 preceding the May commencement when the degree is to be conferred. The dissertation must be submitted at least seven days before the scheduled date of the student's examination.

Doctoral dissertations usually will be published on microfilm through University Microfilms, Ann Arbor, Michigan. Authors may, if they wish, copyright them. An abstract will be published in *Dissertation Abstracts*. Before final typing is completed, the candidate should obtain, in the Graduate School Office, detailed instructions on the procedure, together with a microfilming agreement which is signed and returned when the dissertation is finally deposited in the Graduate School Office.

In brief, all copies of the dissertation, with the original in clean type, will remain in spring binders until after the final examination. Three extra copies of the abstract, carefully written and not more than 600 words long, are submitted when the dissertation is first presented to the Graduate School Office. A non-returnable fee of \$25 is charged for microfilming. If copyright is desired, an additional fee of \$15 is charged. The original and two copies will be bound by Ruzicka Bindery at a cost of \$5 per volume. The student may request that more than three copies be so bound.

**Final Examination.** The final oral examination shall be based primarily upon the dissertation. Questions may, however, be asked in the candidate's major field. Except in unusual circumstances, approved by the Dean, a final examination will be scheduled only when school is in session.

If a student fails in his final examination, he may be allowed to take it a second time, but not sooner than six months from the date of his first. Permission to take the second examination must be obtained from the instructor who directed the dissertation and from the Dean. Failure to pass the second examination renders the student ineligible to continue work for the doctoral degree at Duke University.

# Cooperative Plan of Study





## Program with Selected Colleges and Universities

Since its inception the Duke School of Forestry and Environmental Studies has had the cooperation of Trinity College (the undergraduate college of arts and sciences of Duke University) in preparing students for professional careers in forestry. Under the plan, a student devotes his first three years to a coordinated and carefully integrated program of study in the basic arts and sciences in Trinity College. The following semesters are spent in the School of Forestry and Environmental Studies, and upon successful completion of seventy units of credit in a professional program of study, a student will have earned a baccalaureate degree from Trinity College and the professional Master of Forestry or Master of Environmental Management degree from the Duke School of Forestry and Environmental Studies. In the case of students with advanced preparation relevant to their specific educational objectives, total unit credit requirements may be reduced. Any such reductions will be approved on an individual basis and only with specific recommendations of the student's major program adviser and approval by the faculty.

Based upon the experience and success of this cooperative program with Trinity College, the School of Forestry and Environmental Studies in 1952 initiated similar programs of collaboration with a selected group of colleges and universities located throughout the United States. These programs offer students the numerous advantages of a broad background in liberal arts and sciences as preparation for later professional training. A student intent upon following such a course of study should make application to one of the colleges listed on pages 18-19. Admission requirements and other information pertinent to matriculation may be obtained from each of these institutions. Not later than the end of the first semester of the third year in the college or university of his choice, the student may make formal application for admission to the Duke University School of Forestry and Environmental Studies. To qualify for admission under these programs, a student must have followed a course of study arranged in consultation with his adviser, must have the official recommendation of his college, and must meet requirements for admission to the Duke School of Forestry and Environmental Studies.

## Institutions in the Cooperative Program

### *Alabama*

Samford University, Birmingham 35209

### *Arkansas*

Little Rock University, Little Rock 72204

### *Colorado*

Colorado College, Colorado Springs 80902

### *Florida*

Florida Southern College, Lakeland 33802

Rollins College, Winter Park 32791

Stetson University, College of Liberal Arts, DeLand 32720

### *Georgia*

Mercer University, Macon 31207

### *Illinois*

Illinois Wesleyan University, College of Liberal Arts, Bloomington 61710

### *Indiana*

Butler University, College of Liberal Arts and Sciences, Indianapolis 46208

Franklin College, Franklin 46131

Indiana Central College, Indianapolis 46227

### *Iowa*

Iowa Wesleyan College, Mount Pleasant 52641

### *Kansas*

Baker University, Baldwin 66006

### *Louisiana*

Centenary College of Louisiana, Shreveport 71104

### *Maryland*

Western Maryland College, Westminster 21158

### *Michigan*

Albion College, Albion 49224

### *Mississippi*

Millsaps College, Jackson 39210





*Missouri*

William Jewell College, Liberty 64068

*Nebraska*

Doane College, Crete 68333

*New Jersey*

Drew University, College of Liberal Arts, Madison 07940

Upsala College, East Orange 07019

*New York*

Hofstra University, Hempstead, Long Island 11550

*North Carolina*

Catawba College, Salisbury 28114

Duke University, Trinity College, Durham 27706

Guilford College, Guilford College 27410

High Point College, High Point 27262

Lenoir Rhyne College, Hickory 28601

Wake Forest University, Winston-Salem 27106

*Ohio*

Baldwin-Wallace College, Berea 44017

Denison University, Granville 43023

Heidelberg College, Tiffin 44883

Kent State University, College of Liberal Arts, Kent 44240

Marietta College, Marietta 45750

Miami University, College of Arts and Sciences, Oxford 45056

Ohio University, Athens 45701

Otterbein College, Westerville 43081

Wittenberg University, Springfield 45501

Youngstown State University, Youngstown 44503

*Oregon*

Reed College, Portland 97202

Williamette University, College of Liberal Arts, Salem 97301

*Pennsylvania*

Albright College, Reading 19604

Allegheny College, Meadville 16335

Elizabethtown College, Elizabethtown 17022

Franklin and Marshall College, Lancaster 17603

Gettysburg College, Gettysburg 17325

Juniata College, Huntington 16653

Lebanon Valley College, Annville 17003

Lycoming College, Williamsport 17704

Moravian College, Bethlehem 18018

Muhlenberg College, Allentown 18104

Thiel College, Greenville 16125

*South Carolina*

Furman University, Greenville 29613

Newberry College, Newberry 29108

Presbyterian College, Clinton 29325

*Tennessee*

Carson-Newman College, Jefferson City 37760

Chattanooga, University of, College of Liberal Arts, Chattanooga 37403

East Tennessee State University, Johnson City 37602

Lincoln Memorial University, Harrogate 37752

Tennessee Wesleyan College, Athens 37303

Tusculum College, Greeneville 37743

*Texas*

Baylor University, College of Arts and Sciences, Waco 76706

*Virginia*

Bridgewater College, Bridgewater 22812

Randolph-Macon College, Ashland 23005

Richmond College—University of Richmond, Richmond 23173

William and Mary, College of, Williamsburg 23185

*West Virginia*

Davis and Elkins College, Elkins 26241

Marshall University, Huntington 25701

West Virginia Wesleyan College, Buckhannon 26201

*Wisconsin*

Beloit College, Beloit 53512

# Admission





## Master of Forestry or Master of Environmental Management Degrees

The admission requirements of the School of Forestry and Environmental Studies for work toward the Master of Forestry or Master of Environmental Management degrees presuppose that an applicant is either:

1. a graduate of a professional school of forestry, or
2. a graduate of a college or university of high standing, but without prior professional training in forestry, or
3. a student who has successfully completed three years of approved study at one of the colleges (listed on pages 18-19) in the cooperative program.

Each applicant must present a certified transcript of his academic record showing the courses he has taken, the number of credit hours earned, and the grades received. While few specific courses are required for admission (biology, economics, and mathematics), applicants must be aware that many fields within forestry require academic preparation of a specialized nature. Deficiencies, if any, may be satisfied in residence, possibly prolonging the time necessary to complete degree requirements. Students interested in specialized areas of forestry should write the Dean for advice as to specific preparatory courses.

An applicant who is a graduate of a professional school of forestry will present a certified transcript of his scholastic record. Before registering for the second semester of residence, students will be required to select the branch or branches of forestry in which they wish to concentrate the major part of their work and to prepare their proposed programs in conference with an appropriate faculty advisory committee.

Applicants for all degree programs should plan to take the Graduate Record Examination in the fall preceding application for admission and notice of GRE scores should be sent to the School at time of application.

The Admissions Committee of the School of Forestry and Environmental Studies will evaluate and certify applicants to be admitted to all programs of the School.



## Doctor of Forestry Degree

Admission to the School of Forestry and Environmental Studies for a program of study and research leading to the Doctor of Forestry degree is granted to a student who has received the Master of Forestry degree, or its equivalent.

An applicant must file a formal application for admission together with transcripts of his undergraduate and graduate academic records. In his application he should clearly state the branch of forestry in which he desires to concentrate and, if possible, his specific research interests.







## **Master of Science, Master of Arts, and Doctor of Philosophy Degrees**

Applications for admission into A.M., M.S., and Ph.D. degree programs in Forestry should be submitted to the Director of Admissions, Duke School of Forestry and Environmental Studies, for transmittal to the Office of the Dean of the Graduate School.

A student seeking admission to the Graduate School of Duke University must have received an A.B. or B.S. degree (or the equivalent in the case of foreign students) from an accredited institution. His undergraduate program should be well rounded and of such quality as to give positive evidence of the capacity for graduate study.

Applicants for all degree programs of the School of Forestry and Environmental Studies will be considered for admission without regard to race, color, religion, sex, or national origin.

# Registration and Regulations





## Registration in Forestry and Environmental Studies

All students who enter course work or residence for credit, all students who have completed minimum requirements for an advanced degree but continue to use the facilities of the University in their research, all students with *in absentia* status, and all students who wish merely to audit a course or courses must register.

After applicants have received notice of admission to the School of Forestry and Environmental Studies and have returned a statement of acceptance of admission, they may present themselves for registration. Students entering M.F. programs in the summer must preregister by submitting the application form of the *Summer Session Bulletin* which is mailed to them soon after notice of acceptance of admission is received.

During other registration periods listed in this *Bulletin*, students confer with an assigned faculty adviser who prepares and signs a course card listing the courses to be taken during the semester. Students then present course cards to registration officials who enroll them officially in courses. After first registration, students preregister for succeeding semesters at announced times. Former students intending to resume a degree program must notify the Director of Admissions of this intention at least two months prior to registration.

**Late Registration.** All students are expected to register or preregister at the times stated in this *Bulletin*. Those registering late, including those who are obliged to register *in absentia*, are subject to a late registration fee of \$25.

**Change of Registration.** During the academic year, within a period of fourteen days from the registration date, a student may change registration with the approval of his adviser if no reduction of fee is involved, or with the approval of the Dean if a reduction of fee is involved. During the first thirty days from the registration date, the only permissible change is dropping course-seminar registration and adding equivalent units of research, with the approval of the student's adviser, the instructor of the course, and the Dean. A period of five weeks from the date of registration is provided for changes resulting from passing a preliminary examination.





**Registration in the Graduate School.** A student is designated as fully registered when he registers for the credit his program requires. Required registration is set in consideration of the student's obligation to teach or assist in teaching and the stage he has reached in completion of degree requirements. In the academic year normal registration for the resident student who does not hold an appointment as part-time instructor or assistant or does not engage in part-time work is fifteen units a semester or thirty units an academic year. The normal registration for the student who holds such an appointment or undertakes such work is either twelve units or a minimum of nine units, depending upon the number of hours a week he is required to devote to such duties.

The resident student in a terminal A.M. or M.S. degree program which requires no thesis carries normal registration until he has met all degree requirements. If a thesis is required and the student has met all requirements except for submitting his thesis, he registers for three units a semester while in residence or, if he elects to go out of residence, for one unit *in absentia* each semester until the thesis is accepted.



The resident student engaged in a master's degree program which is not terminal but preparatory to a doctoral program registers as though he were a doctoral student.

The resident student in a doctoral program carries normal registration through the semester in which he passes the preliminary examination. If he remains in residence, he continues to register for a minimum of three units a semester until the dissertation is accepted. If, before or after passing the preliminary examination, he elects to go out of residence, he registers for one unit a semester *in absentia* in order to keep his program active.

It is necessary to be a fully registered student according to the regulations listed above (except when registered *in absentia*) in order to establish eligibility for library carrel and laboratory space, for student housing, for University and some outside loans, and for the Student Health Service including voluntary insurance coverage.

The registration of one unit a semester *in absentia* provides occasional consultation with the thesis or dissertation supervisor. It may be waived for military duty or serious problems of health.

In the *summer session* six units a term is maximum registration. Students who are residents in the academic year and wish to continue study and the use of University facilities including Student Health during the summer must register for one unit in the first summer session term. This registration provides use of these facilities for all terms.

## Academic Regulations

**Grades.** Grades in the School of Forestry and Environmental Studies are as follows: *E* (exceptional); *G* (good); *S* (satisfactory); *F* (failing); and *I* (incomplete).

An *I* (incomplete) indicates that some portion of the student's work is lacking, for an acceptable reason, at the time grades are reported. The instructor who gives an *I* for a course specifies the date at which the student must make up the deficiency, in no case more than one calendar year from the date the course ended. If the course is not completed, the grade of *F* is entered upon the student's record unless his appeal to the Dean for the grade *no credit* is approved. A grade of *F* in any course may result in withdrawal from a degree program.

**Reciprocal Agreements with the University of North Carolina and North Carolina Central University.** Under a plan of cooperation between the University of North Carolina and Duke University, students regularly enrolled in the Graduate Schools of the University of North Carolina during the regular academic year, and paying full fees to that institution, may be admitted to a maximum of two courses per semester in the Graduate School of Duke University upon payment of a nominal registration fee of two dollars and of any other special fees regularly required of all students. Under the same arrangements, students in Forestry and Environmental Studies and the Graduate Schools of Duke University may be admitted to course work at the University of North Carolina and North Carolina State University. A similar arrangement exists with North Carolina Central University at Durham.

# Resources for Study





## General and Research Facilities

The School of Forestry and Environmental Studies is located in the south wing of the Biological Sciences Building on the West Campus. General and research laboratories are provided for routine and original studies in all of the subject matter fields. These laboratories are equipped with instruments and facilities for quantitative evaluation of biological materials and processes. Greenhouses and the phytotron adjoining the Biological Sciences Building and nearby Duke Forest offer excellent facilities for biological investigations in controlled and natural environments. An IBM 370/165 Digital Computer is available for processing research data via terminal facilities at the School. Facilities of allied departments of the University are also available for advanced work in chemistry, economics, genetics, mathematics, plant anatomy, plant ecology, plant physiology, and many other fields.

West Virginia Pulp and Paper Company has made available to Duke University a field headquarters for work in the forests of the South Atlantic Coastal Plain. This camp, located eighteen miles northwest of Summerville, South Carolina, is used as a base for field instruction in timber harvesting, wood utilization, soils, silviculture, and forest management.

The School periodically sponsors conferences and symposia on industrial forest management and other technical and scientific subjects. These offer the current viewpoints of many outstanding individuals both in forestry and in allied fields.

The University library, with 2,000,000 volumes and 4,000,000 manuscripts, provides exceptional resources and facilities for study and research by undergraduate and graduate students and by visiting scholars. About 80,000 volumes are added annually, and 164 foreign and domestic newspapers and 9,800 periodicals are received currently. Large collections of microfilms of rare books, newspapers, and periodicals are also available.

The Biology-Forestry Library, Chemistry Library, and Physics-Mathematics Library are housed for convenience in the buildings of these departments. The libraries of the Schools of Divinity, Law, Medicine, and Engineering are also housed in the buildings of these schools, all on the West Campus. The library on East Campus includes another 171,000 volumes.





**The Duke Forest.** The Duke Forest, of approximately 8,000 acres, is particularly well situated for field work. A five-minute walk from the campus will take one well into many parts of the area, and even the most distant portions can be reached by automobile in about twenty minutes.

At few other places in America are there provisions for extensive field study and research in forestry literally at the door of a large university. This natural outdoor laboratory, so conveniently located and representative of the region, is a most valuable supplement to the instructional, laboratory, and library facilities of Duke University.

The forest lies mainly in Durham and Orange Counties near the eastern edge of the Piedmont Plateau. A cross section of much of the woodlands in the upper Coastal Plain and lower Piedmont of the Southeast is represented in the forest with its variety of topography, soil, forest conditions, and patterns of past land use. Elevations range from 280 to 760 feet. The soils are derived from such diverse parent material as metamorphic rock of the Carolina slate formation, granite, Triassic sedimentary rock, and basic intrusives. Nearly one hundred tree species are represented. Some eighteen miles of improved woods roads make all parts of these woodlands accessible. Duke Forest serves as an outdoor laboratory for instruction in forestry and allied fields, and as an experimental forest for research in problems of timber growing and in related sciences. It is also used to demonstrate methods of silviculture and forest management applicable to the region.

**Forestry Sciences Laboratory.** The establishment of the Forestry Sciences Laboratory of the United States Forest Service's Southeastern Forest Experiment Station in the Research Triangle Park near Durham provides an unusual opportunity for complementing the research programs of students in the School of Forestry and Environmental Studies. Specialized research projects in forest entomology, pathology, and soils are currently under way at the laboratory. The research staff of the laboratory is available for consultation, participation in semi-





nars, and service on graduate committees of students in the School of Forestry and Environmental Studies. Arrangements may also be made for students to conduct certain aspects of their research at the laboratory.

**Phytotron.** A controlled environment plant growth facility adjoins the Biological Sciences Building. The Duke phytotron contains fifty separately controlled environmental areas. In the chambers and greenhouses it is possible to dissect any total environment in the world. Using this procedure, one can study the influence of many environmental factors on the growth processes of trees. The chambers accommodate trees up to six feet tall, the greenhouses even larger plants. The Duke phytotron is one of three such laboratories in the United States.

**Duke Environmental Center.** The Duke Environmental Center is an interdisciplinary University-wide organization for the encouragement and coordination of research and training in environmental subjects. The Center provides students access to course work, research, and expertise in all departments of the University and outside agencies involved in environmentally related activities. It also sponsors environmental courses and seminars and maintains an environmental reading and reference room. Students in the School of Forestry and Environmental Studies may become affiliated with the Environmental Center through working with one of several forestry faculty members who are involved in center activities.

**National Environmental Research Center.** The Durham area has the greatest concentration of Environmental Protection Agency (EPA) offices and activities outside of Washington, D.C. The EPA National Environmental Research Center in the Research Triangle Park is the national center of air pollution research and regulation activities. This facility provides a unique opportunity for cooperative research and advanced training in air pollution and other environmental subjects.

Student  
Life





## Living Accommodations

**Housing.** Duke University provides residence hall and apartment accommodations for single graduate and professional men and women. Duke University has a 500-unit housing facility known as Central Campus Apartments. The complex provides housing for married graduate and professional students, single undergraduate and graduate students, and single and married students in nondegree programs related to allied health.

For single students the efficiencies and one, two, and three bedroom apartments are fully furnished. The apartments for married students include a few furnished efficiencies and a number of one, two, and three bedroom units in which the kitchen, living room, and first bedroom are basically furnished and equipped. Eligible married students will find that the apartments provide economy and convenience yet allow them to introduce individual character by using their own furnishings and accessories.

The monthly rental rates for each type of apartment are lower than those offered on the current local housing market. For further information on these apartments, married and single students should write: Manager of Apartments and Property, Duke University, 217 Anderson Street, Durham, North Carolina 27706.

The University also will provide assistance to married graduate and professional students in locating suitable housing in Durham, where varied types of reasonably priced units are available.

The Graduate Center, near the Medical Center, and Town House Apartments house men and women enrolled on a full-time basis in the graduate and professional schools. Town House Apartments are located between East and West Campuses.

The Graduate Center houses 148 male graduate students, 56 female graduate students, and 117 female undergraduate students. Commons facilities on the main floor are shared by men and women.

Students are usually licensed to occupy graduate residential space for the academic year, but for no period less than a semester or specified term.



Duke University operates Town House Apartments primarily for graduate and professional school students. Others are housed in individual apartments if the interests of the University are served. There are thirty-two two-bedroom units, each furnished for three occupants. Two students occupy the master bedroom with adjoining half-bath, and the third occupies a smaller bedroom. A living room, kitchen, and full bath complete the living arrangement. Additional features are air-conditioning and a swimming pool. The campus bus, serving all parts of the University, is accessible to the Town House Apartments. Students must pay their own utilities for each apartment.

The Department of Housing Management is prepared to assist the married graduate and professional school students in locating suitable housing in Durham. There are many relatively new complexes and a few older apartments. Houses and duplex units are available in limited numbers from time to time.

Detailed information about University housing facilities for single students and the housing assistance program for married students will be provided upon request by the Department of Housing Management, Duke University, Duke Station, Durham, North Carolina 27706.

Rooms and residence halls and spaces in the Town House Apartments or other residential units may be reserved by applicants only if they have been accepted by the graduate or professional schools and after the required \$50 residential deposit has been paid to the University. The initial residential deposit is required with the application and is held until the room or apartment is vacated. Application forms and detailed information on graduate housing will be mailed when the graduate or professional schools have notified the Department of Housing Management of official acceptance of the student. Single students may express a choice for the type of housing desired. Completed applications for rooms and apartments are to be returned with the required deposits to the Department of Housing Management. Assignment priority is established by the date completed applications and deposits are received in this office.





Regulations governing occupancy of rooms and apartments will be provided by the Department of Housing Management at the time application forms are forwarded to accepted students. Occupants within each type of housing are expected to comply with the appropriate regulations.

For the cost of housing, see the section on Financial Information.

**Dining Service.** The dining facilities on the West Campus include two cafeterias with multiple-choice menus, a snack bar, and the Oak Room, where full meals and a la carte items are served. In the Graduate Center there is a cafeteria with multiple-choice menus and a coffee lounge where sodas and sandwiches are served.

Due to the large number served in the dining hall, it is not possible to arrange special diets for individual students.

## Services Available

**Medical Care.** The aim of the University Health Service is to provide medical care and health advice necessary to help the student enjoy being a part of the University community. To serve this purpose, both the University Health Services Clinic and the University Infirmary are available for student health care needs.

The main components of the Health Service include the University Health Services Clinic, located in the Pickens Building on West Campus, and the University Infirmary on the East Campus. Emergency transportation, if required, can be obtained from the Duke Campus Police. Residential staff personnel should be consulted whenever possible for assistance in obtaining emergency treatment.

The facilities of the University Health Services Clinic are available during both regular and summer sessions to all currently enrolled full-time students. The facilities of the University Infirmary are available during the regular sessions only from the opening of the University in the fall until Graduation Day in the spring to all currently enrolled full-time students.

To secure the benefits of the Student Health Program, a graduate student during the terms or semester in which the illness occurs, must (1) in the summer session term be registered for at least one unit of research or three units of course work, (2) be registered for at least nine units per semester if minimum residence requirements have not been met. A student health fee of \$70 (\$35 per semester) is charged to all Duke University students.

Students are not covered during vacations, and their dependents and members of their family are not covered at any time.

The resources of the Duke University Medical Center are available to all Duke students and their spouses and children. Charges for any and all services received from the Medical Center are the responsibility of the student as are the charges for services received from physicians and hospitals not associated with Duke University.

The Student Mental Health Service, under the direction of Dr. W. J. Kenneth Rockwell, is located in the Pickens Rehabilitation Building and provides evaluations and brief counseling and/or treatment for matters ranging from questions about normal growth and development to the most serious psychiatric disorders.

The University has made arrangements for a Student Accident and Sickness Insurance Plan to cover all full-time students for a twelve-month period. For additional fees a student may obtain coverage for a spouse or spouse and child. Although participation in this program is voluntary, the University expects all graduate students to be financially responsible for medical expenses above those covered by the University Student Health Program through the University Acci-



dent and Sickness Policy, a private policy, or personal financial resources. Students who have equivalent medical insurance or wish to accept the financial responsibility for any medical expense may elect not to take the Duke Plan by signing a statement to this effect. *Each full-time student in residence must purchase this student health insurance or indicate the alternative arrangement.* The Student Accident and Sickness Insurance Policy provides protection twenty-four hours per day during the full twelve-month term of the policy for each student insured. Students are covered on and off the campus, at home, while traveling between home and school, and during interim vacation periods. Term of the policy is from opening day in the fall. Coverage and services are subject to change each year as deemed necessary by the University in terms of costs and usage.

**The Duke University Counseling Center.** Through the counseling center, the University provides a professional counseling service designed to aid students in gaining a better understanding of themselves and the opportunities available to them. Counseling is available in the areas of career planning, educational opportunities, and personal and social adjustment.

The center maintains files of educational and vocational information related to career planning, graduate educational programs and fellowships, and study aids.

National and University-wide testing programs are administered by the center. A continuing program of research in the areas of counseling and testing is also carried on by the staff of the center.

**Office of Placement Services.** Duke University maintains an Office of Placement Services which acts as a liaison between the University and potential employers in business, education, and government. All services are offered without charge to Duke students and alumni. The staff is available to talk with students

about their future professional plans. Students who wish to register with the office are offered an opportunity to assemble a complete dossier of academic records and recommendations to supplement applications for positions and to have a permanent file for future reference. Pertinent recommendations are far easier to accumulate during the time a student is enrolled at Duke. Interviews with representatives visiting Duke are scheduled throughout the year through the Placement Office for those students who have registered. Copies of academic records are released only with the permission of the individual.

## **Student Activities**

Students new to Duke University are reminded that they are welcome to use such recreational facilities as swimming pools, tennis courts, golf course, and to affiliate with choral, instrumental, drama, and religious groups.

Students are encouraged to maintain broad professional contacts by participation in the activities of the Society of American Foresters, the Forest Products Research Society, the national honorary scientific society of Sigma Xi, and other societies appropriate to their major field of study.

The social and business events of the Forestry Club provide opportunities for many pleasant extracurricular activities. An active organization of the wives of forestry students, the Forestry Dames, offers a regular schedule for social occasions of interest to this group.

## **Conduct of Students**

Duke University expects and will require of all its students continuing loyal cooperation in developing and maintaining high standards of scholarship and conduct.

The University wishes to emphasize its policy that all students are subject to the rules and regulations of the University which are currently in effect or which are put into effect from time to time by the appropriate authorities of the University.

Any student, in accepting admission, indicates his willingness to subscribe to and be governed by these rules and regulations and acknowledges the right of the University to take such disciplinary action, including suspension and/or expulsion, as may be deemed appropriate, for failure to abide by such rules and regulations, or for conduct adjudged unsatisfactory or detrimental to the University.

## **Visiting Scholars**

The libraries and, to the extent practicable, other facilities of Duke University will be made available to faculty members of colleges and universities who wish to spend a period of time on the campus in pursuit of their scholarly interests. No fees will be charged such visitors unless they wish to participate in activities for which a special fee is assessed. Room and board may be arranged for at the regular rate in the dormitories and dining rooms. Dormitory space is usually available during the summer months. Inquiries concerning residence for visiting scholars should be directed to the Dean of the Graduate School.



# Financial Information







### Tuition and Fees\*

The following table shows the charges collected from all students for the year 1975-1976. All charges for each semester are due and payable at the time specified by the University, and no student is admitted to classes until arrangements have been made with the Bursar of the University for the settlement of such charges. After the beginning of classes, no refund of tuition will be made except for involuntary withdrawal to enter the armed services or in accordance with established University policy.

Tuition, per semester .....	\$ 1,615
Tuition, summer session, per unit .....	86.00
non-laboratory course .....	258.00
laboratory course .....	344.00
Spring field seminars .....	15.00 to 25.00
<i>In Absentia</i> Fee per semester (when applicable) .....	108.00
Student Health Fee, per semester .....	35.00
per Summer Session term .....	12.00

Forestry students may obtain admission to all regularly scheduled University athletic contests held on the University grounds during the entire academic year by payment of an athletic fee of \$25 per year, plus any federal taxes that may be imposed. This fee is payable in the fall semester.

**Tuition Refund Policy.** Tuition refunds are governed by the following policy:

1. In the event of death or a call to active duty into the armed services, a full tuition refund is granted.
2. In all other cases of withdrawal, students or their parents may elect to have tuition charges refunded or carried forward as a credit for later study, according to the following schedule:
  - a. Withdrawal before the beginning of classes: full refund.
  - b. Withdrawal during the first or second week of classes: 80 percent.
  - c. Withdrawal during the third through fifth week: 60 percent.
  - d. Withdrawal during the sixth week: 20 percent.
  - e. No refunds after the sixth week.
  - f. Tuition or other charges paid from grants or loans will be restored to those funds, not refunded or carried forward.

\*Although these fees are based upon existing charges, they are subject to change.

**Late Registration.** Students who register in either semester at a date later than that prescribed by the University must pay the Bursar a fee of \$25.

**Audit Fee.** If a student registers and pays fees for twelve units or more, he may audit one course without charge. Should he be permitted to audit a second course or should he be registered for less than twelve units the audit fee is \$40 per course.

**Transcripts.** A student may request transcripts of his academic record. A minimum fee of \$2, payable in advance, is charged for a single copy. A charge of fifty cents will be made for each additional copy of the same order.

## Debts

No records are released and no student is considered by the faculty as a candidate for a degree until he has settled with the Bursar for all indebtedness.

## Living Accommodations

**Housing Fee.** The charge for each person in a double room for the academic year is \$460 in the Graduate Center. A limited number of single rooms are reserved for returning students.

The fee for Town House Apartments is \$692 per student for the academic year on the basis of three students to an apartment. Utility charges are not included in these fees.

Housing fees are subject to change prior to the 1977-1978 academic year. A \$50 deposit is required on all reservations.

**Refunds.** The \$50 reservation deposit will be refunded to students (1) whom the University does not permit to return, (2) who graduate, or (3) who request the refund prior to registration, thus indicating their intention not to return for the following semester. The reservation deposit will not be refunded to students who register but fail to enter the following semester on schedule.

The section on Living Accommodations in the chapter Student Life describes arrangements for refund of the \$50 room deposit and gives further information on housing facilities.



**Dining Service Fee.** The cost of the dining facilities discussed on page 35 will approximate \$830, depending on the tastes of the individual.

## Motor Vehicles

Each member of the Duke academic community possessing or maintaining a motor vehicle at Duke University is required to register it with the University. Students do so annually at the beginning of the fall semester. If a student acquires a motor vehicle and maintains it at Duke University after academic registration, it must be registered within five calendar days after operation on the campuses begins. Resident students are required to pay an annual fee of \$20 for each automobile or \$10 for each two-wheeled vehicle.

At the time of registration of a motor vehicle, the following documents must be presented: state vehicle registration certificate; valid driver's license; and satisfactory evidence of automobile liability insurance coverage with limits of at least \$10,000 per person and \$20,000 per accident for personal injuries, and \$5,000 for property damage, as required by the North Carolina Motor Vehicle Law.

## Estimated Expenses for the Academic Year

The following table represents an estimate of a graduate student's basic expenses in the School of Forestry and Environmental Studies for the year's 1976-1977. It should be noted, however, that this estimate does not include any allowance for travel, clothing, and other miscellaneous expenses, as these costs will vary depending on the needs, habits, and tastes of the individual.

	<i>Low</i>	<i>Moderate</i>	<i>Liberal</i>
Tuition .....	\$3230.00	\$3230.00	\$3230.00
Room-rent* .....	460.00	585.00	655.00
Board .....	775.00	830.00	885.00
Laundry .....	40.00	50.00	60.00
Books .....	60.00	75.00	110.00
Athletic Fee (Optional) .....	25.00	25.00	25.00
Spring Field Semesters .....	15-25	15-25	15-25

\*In the Graduate Center.

## Student Aid

A number of fellowships, scholarships, and assistantships are allocated to the School of Forestry and Environmental Studies for the encouragement and financial assistance of men and women who offer promise of becoming leaders in their fields. These are awarded to applicants of high character on the basis of scholastic ability as judged by previous educational performance, professional experience, personal references, and the Graduate Record Examination. Holders of the awards will pay tuition and such additional fees as are regularly required.

**Fellowships.** Stipends range from \$2,300 to \$4,000 per academic year. Each recipient must have previously completed work equivalent to that required at Duke University for a master's degree with a major in forestry, environmental studies, or in a related basic discipline. Students receiving fellowships will devote their time to an approved program of study and research in any of the branches of forestry, and they are expected to become candidates for the Doctor of Forestry or Doctor of Philosophy degree.

**Remission of Tuition.** Children of ministers in the North Carolina and the Western North Carolina Annual Conferences of the United Methodist Church may be eligible to receive a remission of the tuition charge for a maximum of eight semesters of undergraduate study at Duke University. Eligibility is met by the parent being in a regular pastoral appointment; when the parent is in a special appointment, eligibility will be determined on an individual basis depending upon the nature of the appointment. In all cases the decision of the University will be final.

**Scholarships.** Stipends range from \$600 to \$3,200 per academic year. Recipients will usually devote their time to an approved program of study leading to the degree of Master of Forestry, Master of Environmental Management, or Master of Science with a major in forestry.

**Graduate Assistantships.** Graduate assistantships have stipends ranging up to \$4,000, depending upon available funds and upon whether granted for the academic year only, or the academic year plus summer. Recipients will devote half time to research or other work of the School of Forestry and Environmental Studies. They will be permitted to enroll for not more than twenty-four units in an academic year in an approved program of study, or program of study and research.

**Application for Awards.** Any student admitted to the School of Forestry and Environmental Studies is eligible to apply for a fellowship, a scholarship, or an assistantship. Application for these awards may be made concurrently with the application for admission.

The general procedures and requirements for applying for any financial award in the School of Forestry and Environmental Studies are outlined below. Applicants should initiate the necessary action early to ensure that the required documents are filed with the Dean of the School of Forestry and Environmental Studies on or before February 1 prior to enrollment. Applicants should:

1. File award application. Form will be supplied by the School of Forestry and Environmental Studies upon request.
2. Furnish supporting documents as follows: (a) official transcripts of records of all previous college or university credits earned and (b) letters of reference from at least three persons familiar with the applicant's character, scholarship, and professional ability. (Documents offered in support of admission, if so designated, may also serve in support of the application for financial award.)
3. Complete the Aptitude Test of the Graduate Record Examination. Instructions and application for admission to this locally administered examination are available on most college campuses, from the Duke School of Forestry and Environmental Studies, or by writing the Educational Testing Service, Princeton, New Jersey. Applicants should plan to take this examination in December or earlier.

Notification of awards is made on March 15. In case vacancies occur, completed applications received after February 1 will be considered at a later date.

In every instance where a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or prospective graduate student and accepted before April 1, the recipient may resign his appointment without prejudice prior to that date by notification in writing to the Dean. However, an acceptance given or left in force after April 1 obligates him not to accept another appointment without first obtaining formal release from the Dean of the School.

## Loans

Students who are enrolled as full-time degree candidates and who have satisfactory academic and citizenship records are eligible to apply for student loans.



**Champion Paper Foundation Fund.** This fund was established in 1971 by a grant of the Champion Paper Foundation in support of the School of Forestry and Environmental Studies. Students may apply for assistance from this fund through the Forestry Financial Aid Office.

**University Student Loans.** The Duke University Federally Insured Loan Program is one of four loan programs specifically designated to help Duke students to meet legitimate educational expenses.

The other loan programs are the National Direct Student Loan program and the restricted University loan programs supported by privately donated funds. We recommend a review of each program to determine the one best suited to the individual student's needs and resources.

Through Duke University and the federal government, students qualify for loans under the Federally Insured Student Loan Program. The federal government assumes risks for loans, thus eliminating the collateral requirement. The University, however, must provide the loan funds for the program. The loan is cancelled in the case of the death or total and permanent disability of the borrower.

The Duke University Federally Insured Loan Program allows the student to borrow up to \$2,500 per year at 7 percent interest. Repayment begins nine months after a student completes his education, and he will have up to ten years following graduation or withdrawal from the University to repay the loan.

An interest subsidy is available from federal funds for all students who have demonstrated need through the Graduate and Professional School Financial Aid Service (GAPSFAS). In order to qualify for the interest subsidy from the government a GAPSFAS form must be submitted. Under the subsidy the federal government will make the interest payments accruing during periods of full-time study, military service, or service in Peace Corps or VISTA.

**Other Funds.** In addition to local loan funds, Duke University participates in the student loan program established under the provisions of the National Defense Education Act of 1958. Repayment of these loan funds usually begins nine months after the student terminates full-time study. Interest accrues at the rate of 3 percent per annum commencing nine months after termination of full-time study. Upon completion of the period of grace of nine consecutive months, the monthly repayment period begins, and simple interest on the loan at the rate of 3 percent starts to accrue.

Special benefits to those teaching in certain public schools permit a portion of the loan to be cancelled, depending upon the length of teaching service.

Applications and complete details regarding the student loan program may be obtained by writing to the School of Forestry and Environmental Studies. In approving loan applications, the Student Loan Committee selects those students who, from the standpoint of financial need, are deserving of this consideration. All applications for loans should be made before July 1 preceding the academic year in which the student plans to matriculate.

# Courses of Instruction





## General

**For. 152. Conserving Natural Resources.** Fundamentals of natural resource development, use, management, and protection based on principles of the natural and social sciences. 3 units. *Staff*

**For. 200. Careers in Natural Resources.** A weekly seminar which surveys the research and managerial career opportunities in all fields of renewable natural resources. Required of students in Academic-Forestry program. No credit. *Staff*

## Forest Biology

### DENDROLOGY AND WOOD ANATOMY

**For. 206. Anatomy of Woody Plants.** Primary and secondary structures in seedlings and in mature trees, shrubs, and vines. Preparation techniques for gross observations and for study of micro- and ultra-structures with light and electron microscopy. Relationship of microstructures to growth habits and physical properties of woody plant parts. Comparative studies in relation to ecological and systematic topics. 4 units. *Philpott*

**For. 241. Dendrology.** Nomenclature, classification, and identification of woody plants, with special reference to the tree species indigenous to the southeastern United States and other important forest regions of temperate North America. Prerequisites: Biology 1-2 or equivalent. 3 units. *White (Summer Session)*

**For. 292. Microtechnique of Woody Tissue.** Preparation of wood for microscopic study including sectioning, staining, and mounting techniques; elementary photomicrography. Prerequisites: Forestry 241 and 206 or equivalents and approval of instructor. (Offered alternate years on sufficient demand.) 3 units. *Philpott*

Related courses in other departments include—*Botany*: Anatomy, Systematics, Physiology; *Chemistry*: Organic Chemistry; *Civil Engineering*: Mechanical Behavior of Materials.

## ECOLOGY

**E.S. 243. Natural Resource Ecology.** An introduction to modern ecology with emphasis on natural resource management. Emphasis put on the ecosystem as the basic unit of management. Prerequisite: consent of instructor. 3 units. *Staff*

**E.S. 337. Ecological Analysis for Environmental Management.** Methods of analyzing ecosystems for environmental impact assessment, land use planning, and other environmental management applications. Lectures, laboratory, and field work in use of maps, aerial photographs, and field surveys for interpretation of physiographic and biological characteristics of terrestrial ecosystems. Prerequisites: Environmental Studies 243 and 341 and consent of instructor. 3 units. *Staff*

**E.S. 340. Ecology and Land Use Planning.** Consideration of the properties and processes of the natural environment as they relate to land use. Exploration of the biological, economic, legal, and social aspects of the application of ecological principles to the land use planning process. Prerequisites: Environmental Studies 341 and consent of instructor. 3 units. *Staff*

**E.S. 341. Ecological Principles in Environmental Management.** Discussion of the application of ecological principles to environmental manipulation. Methods of planning and managing human use of ecosystems while avoiding environmental deterioration. Stress put on the biological viewpoint. Prerequisites: general ecology and Environmental Studies 243 or other substantive coursework in ecology. 3 units. *Staff*

**E.S. 346. Seminar in Environmental Policy.** Discussion of the political, legal, and socioeconomic aspects of public and private action in environmental quality control and management. Prerequisites: Forestry 269 and Environmental Studies 341 or their equivalents, and consent of instructor. 1 unit. *Convery*

**E.S. 347, 348. Natural Resource Ecology—Environmental Management Seminar.** Discussion of current ecological and environmental problems and research topics related to the management of natural resources. Credits to be arranged. *Knoerr*

**E.S. 354. Biological and Resource System Simulation.** Introduction to systems terminology. Differential and difference equations. Probabilistic concepts. Time and event simulations using problem oriented languages such as CSMP, SYNAMO, and GPSS. Applications in biological and resource sciences. Prerequisite: Forestry 250 and 253, or consent of the instructor. 3 units. *Rajagopal*

Related courses in other departments include—*Botany*: Ecology, Plant-Water Relations, Community Analysis and Classification, Principles of Plant Distribution, The Environment, Vegetation of North America, Evolution; *Zoology*: Animal Behavior, Vertebrate Zoology.

## PHYSIOLOGY AND BIOCHEMISTRY

**For. 205. Tree Growth and Development.** Life processes, growth, and development of trees, with emphasis on physiological processes and environmental influences on structure, composition, and function. 3 units. *Barnes (Summer Session)*

**For. 207. Chemistry of Woody Tissues.** Composition of wood at the elemental, molecular, and macromolecular levels, both in woody plants and in processed woods. Distribution and properties of main components and methods of analysis. Prerequisite: organic chemistry or consent of instructor. 3 units. *Barnes*



**For. 208. Physiology of Wood Formation.** Processes involved in the growth and development of woody tissues, including internal control mechanisms and effects of environmental stresses on structure and composition. Prerequisites: Forestry 201 and 241 or equivalents. 3 units. *Barnes*

**For. 305. Forest Biochemistry.** Biochemistry applied to structure and function of woody plants and associated fungi and insects. Prerequisites: courses in plant physiology and chemistry. 3 units. *Barnes*

Related courses in other departments include—*Botany*: Anatomy, Plant Metabolism, Plant-Water Relations, Physiology of Growth and Development; *Biochemistry*: Introductory Biochemistry, Chemistry of Natural Products; *Chemistry*: Organic Chemistry, Chemical Instrumentation.

## **PATHOLOGY**

**For. 222. Biology of Forest Insects and Diseases.** Fundamentals of entomology and plant pathology as applied to forest protection; coordinated laboratory work, with emphasis on identification and interpretation of forest and wood degradation. 4 units. *Anderson and Stambaugh*

**For. 223. Forest Pathology.** Survey of major diseases of North American forests and their timbers, with emphasis on current literature. Field and laboratory study in diagnosis and infection biology. Prerequisite: Forestry 222 or equivalent, or consent of instructor. 4 units. *Stambaugh*

**For. 321. Phytopathological Technique in Forestry.** Fundamentals of phytopathology as applied to field and laboratory investigations of tree diseases and wood degradation; biological interpretation of host-pathogen-environment interaction is stressed in literature review, experimentation, and scientific writing. Prerequisite: Forestry 223 or equivalent. 4 units. *Stambaugh*

**For. 322. Microbiology of Forest Soils.** Qualitative and quantitative characterization of the microbial populations of forest soils, with emphasis on rhizosphere interactions in root pathogenesis and mycorrhizal development; epidemiology of root diseases of trees; principles of control. Prerequisite: consent of instructor; mycology or bacteriology is recommended. 4 units. *Stambaugh*

**For. 385. Seminar in Forest Protection.** Discussion of current problems in entomology and pathology and evaluation of topical research for protection and control application in forest resource management. Prerequisites: Forestry 223 and 230. 1 unit. *Anderson and Stambaugh*

Related courses in other departments include—*Botany*: Mycology, Plant-Water Relations, Physiology of Growth and Development, Cytology, Genetics; *Chemistry*: Organic Chemistry; *Zoology*: Biological Nucleonics; *Biochemistry*: Introductory Biochemistry.

## **ENTOMOLOGY**

**For. 222. Biology of Forest Insects and Diseases.** (See description under Pathology above.)

**For. 225. Chemical Aspects of Forest Protection.** Chemical aspects of organisms attacking trees and of the materials used in their control. Emphasis on structures and properties in relation to functions and uses. Prerequisite: Forestry 222. 3 units. *Barnes*

**For. 230. Forest Entomology.** Identification, biology, and control of insects that cause damage to trees and wood products. Emphasis of diagnosis is on the characteristics of the damage and the stages of the insects responsible. Prerequisite: Forestry 222 or equivalent, or consent of instructor. 4 units. *Anderson*.

**For. 233. General Entomology.** Principles of morphology, metamorphosis,

and taxonomy of insects. Prerequisite: one course in entomology or zoology, or consent of the instructor. (Offered alternate years on sufficient demand.) 4 units. *Anderson*

**For. 331. Toxicology of Insecticides.** Study of the physical, chemical, and biological properties of materials used to destroy insects. Formulation, toxicology, and insect physiology as related to insecticide action are emphasized. Prerequisite: one course in entomology; organic chemistry is recommended. (Offered alternate years on sufficient demand.) 3 units. *Anderson*

**For. 332. Ecology of Forest Insects.** The influence of environmental factors on the vital processes of insects, with emphasis on how both the abiotic and biotic elements influence the fluctuation of forest insect populations. Prerequisite: one course in entomology or zoology, or consent of the instructor. 3 units; 4 units with laboratory. *Anderson*

**For. 335. Entomological Research Techniques.** Problem analyses, scientific writing, and laboratory and field research methods which are especially applicable to entomological problems. 2 units. *Anderson*

**For. 385. Seminar in Forest Protection.** (See description under Pathology above.)

Related courses in other departments include—*Zoology*: Ecology, Systematic Zoology, Radiation Biology, Biological Nucleonics, Cellular Physiology, Invertebrate Embryology, Genetics; *Chemistry*: Organic Chemistry; *Biochemistry*: Introductory Biochemistry; *Botany*: Bacteriology; *Microbiology and Immunology*: Microbiology.

## Environmental Science

**E.S. 347, 348. Natural Resource Ecology—Environmental Management Seminar.** (See description under Ecology above.)

### SOILS

**For. 261. Soils and Forest Resources.** Origin, development, and classification of soils, with special emphasis on those developed in humid climates; morphological, physical, and chemical properties of soils in relation to growth of trees; effect of forests on soils. Prerequisites: Chemistry 1 and 2 and Physics 1, or equivalents; physical geology, mineralogy, petrology, and analytical chemistry are also desirable. 3 units. *Ralston*

**For. 362. Forest Soil Physics.** Analysis of the physical properties of soil related to the growth and development of forest trees. Consideration is given to the significance of soil moisture, temperature, aeration, and structural characteristics in the analysis of forest growth relationships. Prerequisite: Forestry 261. (Offered on sufficient demand.) 3 units. *Ralston*

**For. 364. Soil Classification and Mapping.** Classification of soils as natural bodies. Mapping of soils, land-use classes and forest-site classes; field study will be made of soil in either the coastal plain or mountains. Prerequisite: Forestry 261. 3 units. *Ralston*

**For. 366. Forest Soil Fertility.** The relationship of soil fertility factors in the growth of forest trees. Emphasis is placed on the analysis of soil factors related to the mineral nutrition of trees. Prerequisite: Forestry 261; analytical chemistry is recommended. (Offered on sufficient demand.) 3 units. *Ralston*

Related courses in other departments include—*Botany*: Plant-Water Relations, Physiology of Growth and Development; *Biochemistry*: Introductory Biochemistry; *Chemistry*: Chemical Instrumentation, Elements of Theoretical Chemistry; *Geology*: Sedimentary Minerals.

## METEOROLOGY

**For. 203. General Meteorology.** A general introduction to the science of meteorology, particularly for students concerned with problems in biology and hydrology. Emphasis is placed on the fundamentals and role of atmospheric thermodynamics and energy and mass transfer processes in determining both local and regional aspects of weather and climate. 3 units. *Vukovich*

**For. 204. Microclimatology.** Introduction to the micrometeorological processes. Discussion of the integration of these processes and the resulting microclimates in the rural (forest, field, and water surface) and urban environments. Methods for modification of the microclimate. 3 units. *Knoerr*

**For. 215. Air Pollution Meteorology.** The theory of transport and diffusion of air pollutants and its application to practical problems and computations involving both single sources and multiple sources, including urban communities; modeling of transport and diffusion, both in wind tunnels and computers; stack design from the meteorological point of view; the organization of meteorological networks and field studies; the measurement, monitoring, and equipment requirements of pertinent meteorological parameters; air pollution climatology; meteorological management of air pollution. Prerequisite: Forestry 203 or equivalent. (Course sponsored by Triangle Universities Consortium on Air Pollution and taught by faculty from North Carolina State University.) 3 units. *Staff*

**For. 217. Environmental Instrumentation.** Consideration of the physical basis for measuring parameters of natural and controlled environments. Properties and effective utilization of contemporary electronic measurement and data acquisition systems, including transducers, signal conditioners, and analog and digital recorders. Methods for obtaining and processing computer compatible records. Precision measurement and calibration techniques with primary and secondary laboratory standards. Two lectures and three laboratory hours per week. Prerequisite: consent of the instructor. Students should have a basic knowledge of the properties of environmental parameters and be able to write computer programs. 4 units. *Knoerr*

**For. 304. Atmospheric Turbulence and Diffusion.** Bulk and molecular aspects of atmospheric turbulence; Navier-Stokes equations and the Reynold's stresses; mixing-length and statistical turbulence theories; similarity hypotheses; turbulent transfer and diffusion in adiabatic and diabatic atmospheres; characteristics of turbulence in various scales of motion from the planetary to sub-inertial range. Prerequisites: Forestry 203 and differential equations, or consent of instructor. 3 units. (Offered on sufficient demand.) *Vukovich*

**For. 306. Dynamics of Local Atmospheric Motion.** Characteristics of atmospheric motion in the 100 m to 100 km scale. Analytic development from hydrodynamic and thermodynamic equations, incorporating appropriate scale-forcing functions of heating and terrain roughness. Theory and characteristics of land and sea breezes, mountain and valley breezes, mountain waves, and local modification of large scale atmospheric motion. Prerequisites: Forestry 203 and differential equations, or consent of instructor. 3 units. (Offered on sufficient demand.) *Vukovich*

**For. 344. Micrometeorology and Biometeorology Seminar.** Advanced topics in the physics of the earth's surface environment with emphasis on plant and animal microclimates; budgets of mass, momentum, and energy; vertical structure of wind, temperature, water vapor, and carbon-dioxide in relation to ex-

change processes within the biosphere. Prerequisite: Forestry 204 or equivalent and consent of instructor. 2 units. (Offered on sufficient demand.) *Knoerr*

Related courses in other departments include—*Mechanical Engineering*: Fluid Mechanics, Thermodynamics, Heat Transfer, Transport Phenomena, Boundary Layer Theory; *Mathematics*: Applied Mechanical Analysis, Numerical Analysis; *Chemistry*: Physical Chemistry, Chemical Instrumentation; *Botany*: Ecology, Plant-Water Relations.

## HYDROLOGY

**For. 216. Watershed Hydrology.** Influence of vegetation, soil types, and land forms of water yield, water quality, and flood potential. Analysis of precipitation patterns, infiltration rates, erosion forces, and sediment carrying capacities of streams. Techniques and research methods used to control the hydrologic cycle, water quality, and water yield on wild lands. 3 units. *Hellmers*

**For. 342. Hydrologic Processes.** Physical processes of the hydrologic cycle, with emphasis on those processes which can be modified or controlled by watershed management. 3 units. (Offered on sufficient demand.) *Knoerr*

Related courses in other departments include—*Civil Engineering*: Hydrology, Incompressible Fluid Flow, Mechanics of Fluids; *Mechanical Engineering*: Transport; *Chemistry*: Physical Chemistry, Chemical Instrumentation; *Botany*: Ecology, Plant-Water Relations.

## Resource Economics and Management

### ECONOMICS AND POLICY

**For. 269. Resource Economics and Policy.** Development and critical review of concepts useful in understanding and evaluating the distribution of natural resource use over time in terms of the relations between technological knowledge, group and individual behavior, and social institutions. 3 units. *Convery*

**For. 270. Economics of Forestry.** Development of the principles of economics useful in the analysis of the past, present, and prospective supply and demand situations for forestry goods and services; problems of the economics of the firm and industry basic and peculiar to forestry with special attention to the time dimensions of value; the role of forestry in the general economy, including attention to relevant institutional factors. Prerequisite: Forestry 269 or equivalent. 3 units. *Convery*

**For. 271. Financial Management.** Analysis of the problems of management of the financial affairs of the firm: working capital, long-term capital needs, including the development of an optimal capital structure, with attention to tax problems. 3 units. *Joerg*

**For. 272. Business Policy.** An integrating course where, through analysis of case problems from the top management viewpoint, the student is given practice in arriving at effective courses of action for the solution of business problems. 3 units. *Joerg*

**E.S. 273. Economics and Environmental Quality.** Consideration of the economic dimensions of the environmental problem. Exploration of the reasons for market failure; investigation of possible remedies, including a tax on residuals and direct control. Examination of the modifications required in cost-benefit and input-output analysis to incorporate environmental values. Discussion of economic growth, natural resource scarcity, and environmental quality. Prerequisite: consent of instructor. 3 units. *Convery*

**For. 277. Seminar in Natural Resource Allocation and Efficiency.** Evaluation of economic principles concerned with problems of natural resource allocation.



tion, with special attention to the alternatives for governmental policies in private property economics. Prerequisite: an advanced-level course in non-market decision-making or Forestry 378 or its equivalent. 1 unit. *Convery*

**For. 378. Seminar in Forest Economics.** Examination and discussion of the application of economic concepts in forestry; the potential contribution of economic analysis to private and public forest management; current research in forest economics. Prerequisites: Forestry 270 or consent of the instructor; advanced courses in economics and economic theory are desirable. 2 units. *Convery*

Related courses in other departments include—*Economics*: Economic Theory, History, and Systems; Economic Development, Planning, and Fluctuations; Economic Statistics; Monetary and Fiscal Theory and Institutions; International Economics; Manpower, Labor, and Population; Industrial Organization and Public Policy; *Business Administration*: Business Finance, Marketing, and Accounting.

## MANAGEMENT

**For. 210. Forest Utilization.** Introduction to utilization in the managed forest and the principal wood-using industries. A one-week field seminar is an integral part of the course. The field seminar (without the course) can be taken by non-forestry majors. 1 unit, field seminar only; 2 units with course. *Yandle*

**For. 244. Theory and Practice of Silviculture.** Principles governing establishment, treatment, and control of forest stands; natural and artificial methods of reproduction, intermediate cuttings, and cultural operations, with emphasis on the principal forest types of temperate North America. Field practice in silvicultural operations and study of managed stands. Prerequisite: Forestry 243 or equivalent. 2 units; 3 units with laboratory. *White*

**For. 245. Management of Small Woodlands.** Practical application of principles of forest management to small tracts. Field examinations, compilation of data, negotiations and actions for landowners in diverse market and tax situations. 3 units. *Staff*

**For. 247. Forest Recreation and Landscape Management.** Focuses on developing a methodology for the integration of forest recreation and management practices that enhance and preserve the visual characteristics of the landscape. Emphasis will be placed on (1) the recognition and appreciation of natural landforms and cultural landscapes, (2) the evaluation of important ecological and natural processes that further define the landscape and place limits on its use, (3) the interaction of factors influencing the potential recreational use of forest lands, and (4) an examination of potential criteria for use of forest lands, and (5) the evaluation of alternative management strategies. Prerequisite: consent of instructor. 3 units. *Staff*

**For. 248. Forest Regeneration.** The fundamentals and application of forest tree improvement, nursery operations, and site-improvement techniques to the regeneration of forest stands by artificial and natural means. 3 units. *White*

**For. 256. Forest Measurements.** Application of plane-surveying technique to the measurement of land area, topography, and timber type; measurement of volume and growth of forest trees and stands; measurement of forest products. 4 units. *White (Summer Session)*

**For. 281. Forest Management.** Principles of organizing forest properties for systematic management; use of data obtained in surveys and inventories; principles of forest regulation, including a study of normal and actual forests, rotations, cutting cycles, and methods of regulating the cut in even-aged and all-aged forests for sustained yield; introduction to the preparation of preliminary forest management plans. 3 units. *Staff*

**For. 283. Fire Behavior and Use.** Impact of destructive agencies upon forests; principles of combustion, fire behavior, danger measurement, and suppression; use of fire in forest management. 2 units. *Staff*

**For. 289. Interpretation of Aerial Photographs.** Principles of aerial photography and remote sensing as applied to forest administration, vegetation mapping, forest mensuration, and insect and disease surveys. Corequisite: Forestry 281 or equivalent. 2 units. *Staff*

**E.S. 349. Wildland and Wildlife Management.** The paradox of managed natural systems is considered in the context of plant, animal, and human population dynamics. Topics include vegetation management, wildlife management, and wilderness recreation management, including camping, backpacking, hunting, and fishing. Special attention is paid to wildland preserve and open space planning. 3 units. *Staff*

**For. 382. Legal Aspects of Forestry.** A seminar on certain state and federal laws pertinent to the management of forests: land ownership, trespass, public liability, timber contracts, labor relations, and use of pesticides. 1 unit. *Staff*

**For. 386. Seminar in Forest Management.** Examination and analysis of techniques employed in the management of industrial and public forests, particularly in the south; discussion of problems of large scale intensive forest management. Prerequisites: Forestry 244, 281, and 377 or equivalent. 1 unit. *Staff*

Related courses in other departments include—*Business Administration*: Theory of Firm, Organization Theory, Information Systems, The Firm in Society; *Political Science*: Public Administration; *Social Science*: Social Stratification, Industrial Sociology.

## Statistics and Operations Research

**For. 250. Biometry.** Concepts and methods of statistics essential to the collection, analysis, and interpretation of resource and biological data. Emphasis is placed on problems of estimation, inference, and decision-making with experimental data. 3 units. *Yandle*

**For. 251. Theory and Methods for Sampling Biological Populations.** Introductions to statistical methods for sampling natural resources and biological populations. Simultaneous consideration is given to theoretical and experimental problems in the design and applications of sampling methods and in the interpretation of sample data. Prerequisite: Forestry 250 or consent of instructor. 3 units. *Yandle*

**For. 253. Computer Science in Natural Resources.** Introduction to the organization of information storage and retrieval systems. Extensive use of Fortran (WATFIV) programming and statistical packages (SAS, TSAR) in resource and environmental decision making. 3 units. *Rajagopal*

**For. 258. Quantitative Analysis in Resource Management.** Mathematical model formulation and analysis in resource and environmental decision making. Includes a survey of applications of linear programming, dynamic programming, CPM-PERT, inventory and statistical quality control in the resource sciences. Use of APL and MPS programming systems. 4 units. *Rajagopal*

**For. 352. Theory and Applications of Linear Statistical Models.** Theoretical development of the general linear statistical model, together with extensions to accommodate linear approximation of nonlinear cases. Curve-fitting techniques are developed, with emphasis on applications to natural phenomena. Prerequisite: consent of the instructor. 3 units. *Yandle*

**For. 353. Design and Analysis of Experiments.** Extension of the theory of estimation and testing for general linear models to include the less than full rank case. Experimental design models such as factorial and incomplete block models and developed as special cases of the general theory. Emphasis is placed on field and laboratory designs, together with appropriate computerized analysis techniques. Prerequisite: Forestry 352. 3 units. *Rajagopal*

**E.S. 354. Biological and Resource System Simulation.** (See description under "Ecology" above.)

Related courses in other departments include—*Mathematics*: Calculus, Numerical Analysis, Complex Analysis, Non-parametric, Statistics, Probability, Applied Mathematical Statistics, Stochastic Processes, Multivariate Statistics; *Economics*: Econometrics, Quantitative Analysis.

## Special Studies and Research

**For. 299. Special Studies in Forestry.** Work on the senior-graduate level to meet the needs of individual students offered in the areas of forestry and related natural resources designated under Forestry 357, 358. Credits and hours to be arranged. *Staff*

**E.S. 299. Independent Projects in Environmental Studies.** Work at the senior-graduate level to meet the needs of individual students in several areas of environmental studies. Credits and hours to be arranged. *Staff*

1. Environmental Planning
2. Environmental Economics
3. Applied Ecology
4. Environmental Education
5. Environmental Communication and Media
6. Environmental Ethics and Values
7. Environmental Design
8. Environmental Policy
9. Environmental Systems Analysis

**For. 301, 302. Advanced Studies in Forestry.** Work on the advanced graduate level to meet the needs of individual students is offered in the areas of forestry and related natural resources designated under Forestry 357, 358. Credits and hours to be arranged. *Staff*

**E.S. 301, 302. Advanced Projects in Environmental Studies.** Independent work at the advanced graduate level in areas designated under Environmental Studies 299. *Staff*

**E.S. 357, 358. Research in Environmental Studies.** Independent work at the advanced graduate level in areas designated under Environmental Studies 299. Credits and hours to be arranged. *Staff*

**For. 357, 358. Research in Forestry.** Students with adequate training may undertake special research problems under direction of members of the faculty in the following branches of forestry and related natural resources. Credits to be arranged. *Staff*

1. *Forest Ecology.* Prerequisite: Environmental Studies 243 or equivalent. *Staff*
2. *Forest Soils.* Prerequisite: Forestry 261 or equivalent. *Ralston*
3. *Silviculture.* Prerequisite: Environmental Studies 243 and Forestry 244 or equivalents. *White*
4. *Forest Management.* Prerequisite: Forestry 281 or equivalent. *Staff*
5. *Forest Economics.* Prerequisite: Forestry 270 or equivalent. *Convery*
6. *Wood Anatomy and Properties.* Prerequisites: Forestry 241 and 206 or equivalents. *Philpott*
7. *Forest Mensuration and Biometry.* Prerequisites: Forestry 250 and 352 or equivalents. *Yandle*
8. *Forest Entomology.* Prerequisite: Forestry 230 or equivalent. *Anderson*
9. *Forest Operations Research.* Prerequisite: consent of instructor. *Rajagopal*
10. *Dendrology.* Prerequisite: Forestry 241 or equivalent. *White*

11. *Forest-Tree Physiology*. Prerequisites: plant physiology and plant or forest ecology. *Barnes and Hellmers*
12. *Forest Pathology*. Prerequisites: plant physiology and Forestry 223 or equivalents. *Stambaugh*
13. *Forest Meteorology and Hydrology*. Prerequisites: Forestry 203, 342, or equivalents. *Knoerr*
14. *Forest Biochemistry*. Prerequisites: plant physiology and organic chemistry. *Barnes*
15. *Regional Land Use Planning*. Prerequisites: Environmental Studies 337 and 340. *Staff*
16. *Environmental Studies*. Prerequisites: consent of instructor. *Staff*

**368. Field Seminars.** Field studies, consultation, and visits to areas of interest during spring vacation period, or at other times, in the several branches of forestry and related natural resources listed under Forestry 357, 358. Credits to be arranged. *Staff*

## Numerical Listing of Courses

### Forestry Courses

152. Conserving Natural Resources. 3 units
200. Careers in Natural Resources. No credit
203. General Meteorology. 3 units
204. Microclimatology. 3 units
205. Tree Growth and Development. 3 units (Summer Session)
206. Anatomy of Woody Plants. 4 units
207. Chemistry of Woody Tissues. 3 units
208. Physiology of Wood Formation. 3 units
210. Forest Utilization. 1 unit, seminar only; 2 units, course and seminar
215. Air Pollution Meteorology. 3 units
216. Watershed Hydrology. 3 units
217. Environmental Instrumentation. 4 units
222. Biology of Forest Insects and Diseases. 4 units
223. Forest Pathology. 4 units
225. Chemical Aspects of Forest Protection. 3 units
230. Forest Entomology. 4 units
233. General Entomology. 4 units
241. Dendrology. 3 units (Summer Session)
244. Theory and Practice of Silviculture. 2 units; 3 units with laboratory
245. Management of Small Woodlands. 3 units
247. Forest Recreation and Landscape Management. 3 units
248. Forest Regeneration. 3 units
250. Biometry. 3 units
251. Theory and Methods for Sampling Biological Populations. 3 units
253. Computer Science in Natural Resources. 3 units
256. Forest Measurements. 4 units (Summer Session)
258. Quantitative Analysis in Resource Management. 4 units
261. Soils and Forest Resources. 3 units
269. Resource Economics and Policy. 3 units
270. Economics of Forestry. 3 units
272. Business Policy. 3 units
277. Seminar in Natural Resource Allocation and Efficiency. 1 unit
281. Forest Management. 3 units
283. Fire Behavior and Use. 2 units
289. Interpretation of Aerial Photographs. 2 units
292. Microtechnique of Woody Tissue. 3 units
299. Special Studies in Forestry. Credits to be arranged
- 301-302. Advanced Studies in Forestry. Credits to be arranged
304. Atmospheric Turbulence and Diffusion. 3 units
305. Forest Biochemistry. 3 units
306. Dynamics of Local Atmospheric Motion. 3 units
321. Phytopathological Technique in Forestry. 4 units
322. Microbiology of Forest Soils. 4 units
331. Toxicology of Insecticides. 3 units
332. Ecology of Forest Insects. 3 units; 4 units with laboratory
335. Entomological Research Techniques. 2 units



- 342. Hydrologic Process. 3 units
- 344. Micrometeorology and Biometeorology Seminar. 2 units
- 352. Theory and Applications of Linear Statistical Models. 3 units
- 353. Design and Analysis of Experiments. 3 units
- 357-358. Research in Forestry. Credits to be arranged
- 362. Forest Soil Physics. 3 units
- 364. Soil Classification and Mapping. 3 units
- 366. Forest Soil Fertility. 3 units
- 368. Field Seminars. Credits to be arranged
- 378. Seminar in Forest Economics. 2 units
- 382. Legal Aspects of Forestry. 1 unit
- 385. Seminar in Forest Protection. 1 unit
- 386. Seminar in Forest Management. 1 unit

#### Environmental Studies Courses

- 243. Natural Resource Ecology. 3 units
- 273. Economics and Environmental Quality. 3 units
- 299. Independent Projects in Environmental Studies. Credits to be arranged
- 301-302. Advanced Projects in Environmental Studies. Credits to be arranged
- 337. Ecological Analysis for Environmental Management. 3 units
- 340. Ecology and Land Use Planning. 3 units
- 341. Ecological Principles in Environmental Management. 3 units
- 346. Seminar in Environmental Policy. 1 unit
- 347-348. Natural Resource Ecology—Environmental Management Seminar. Credits to be arranged
- 349. Wildland and Wildlife Management. 3 units
- 354. Biological and Resource Systems Simulation. 3 units
- 357-358. Research in Environmental Studies. Credits to be arranged



# Appendix

## ENROLLMENT

### Registered for the Master of Forestry Degree

Adams, James John (B.S., Elizabethtown College), Elysburg, Pennsylvania  
Albrecht, Michael Howard (B.S., Doane College), Hickman, Nebraska  
Allen, Steven John (B.S., Rutgers University), Morristown, New Jersey  
Anderton, David Edward, Jr. (B.S., University of Richmond), Williamsburg, Virginia  
Bailey, Susan Elizabeth (B.A., Gettysburg College), Harrisburg, Pennsylvania  
Beatty, Jerome Shalley (B.A., Wabash College), Cranford, New Jersey  
Boone, Andrew Justus (B.S., Newberry College), Irmo, South Carolina  
Brooks, Graham Peter (B.A., Lycoming College), Ossining, New York  
Brown, Charles Richard (B.S., Elizabethtown College), Gibsonia, Pennsylvania  
Brown, Hunter (B.S., University of the South), Birmingham, Alabama  
Carothers, William Albert (B.A., Gettysburg College), Carlisle, Pennsylvania  
Carroll, Francis Joseph (B.A., Bucknell University), Glenolden, Pennsylvania  
Colgan, Thomas John (B.S., Duke University), Rochester, New York  
Considine, Thomas J., Jr. (B.S., Rutgers University), Cherry Hill, New Jersey  
Corredor-Trejo, José Rolando (Forest Engineer, University of Andes), Mérida, Venezuela  
Crosby, Douglas McDonald (B.S., Juniata College), Chalfont, Pennsylvania  
Crum, Sherri Faye (Marshall University), St. Albans, West Virginia  
Curcio, Gary Matthew (B.S., Albright College), Brooklyn, New York  
Davies, Mark Donald (B.A., Lycoming College), Allentown, Pennsylvania  
Dekker, Robert Anthony (B.S., Calvin College), Wyckoff, New Jersey  
DeWald, Scott Joseph (Doane College), Hebron, Nebraska  
Dorset, Richard David (B.S., Lebanon Valley College), Dover, Pennsylvania  
Dowling, Dana Terrence (Butler University), Fairfield, Connecticut  
Easter, Geoffrey Brent (B.S., Ohio University), Franklin Furnace, Ohio  
English, James Thomas (B.A., Johns Hopkins University), Cincinnati, Ohio  
Evans, David Wayne (B.S., Duke University), Springfield, Virginia  
Farrell, Peter (Franklin and Marshall College), Oceanside, New York  
Fox, David Arthur (B.A., Thiel College), Jefferson, Ohio  
Gallemore, Paul Stanley (William Jewell College), Kansas City, Missouri  
García Colmenarez, José Rafael (Forest Engineer, University of Andes), Mérida, Venezuela  
Gearhart, Brent Coulter (B.A., Gettysburg College), Reedsville, Pennsylvania  
Gilliam, Frank Stuart (B.S., Vanderbilt University), Lexington, Kentucky  
Griswold, Mona (B.A., Drew University), Croton-on-Hudson, New York  
Hawthorne, John Elliott (Denison University), Chicago, Illinois  
Hearnsberger, John Charles (B.A., Hendrix College), Little Rock, Arkansas  
Highsmith, George William (B.S., University of Richmond), Thomasville, North Carolina  
Hitchings, John Brooks (B.A., Gettysburg College), East Aurora, New York  
Holland, Bruce George (B.A., Albright College), Shoemakersville, Pennsylvania  
Huff, Mark Hamilton (B.A., Albright College), Chappaqua, New York  
Hyman, Lloyd Louis (Drew University), Clifton, New Jersey  
Kane, Susan Peters (Franklin and Marshall College), Tenafly, New Jersey  
Keith, Sherry Lynn (B.A., Elizabethtown College), Glen Mills, Pennsylvania  
Klapproth, Michael Alan (B.A., Wittenberg University), Cincinnati, Ohio  
Knutson, Gary Robert (B.S., Davis and Elkins College), Brookside, New Jersey  
Kucera, Robert Clarence (B.S., Kent State University), Kent, Ohio  
Lerich, Brian Walter (B.A., Yale University), White Plains, New York  
LoGrasso, Frank Anthony (B.B.A., Cleveland State University), Mayfield Heights, Ohio  
Lutz, John Kenneth (B.S.F., University of New Hampshire), Hollis, New Hampshire  
McCulloch, William Ness (Albion College), Springfield, Ohio  
Merrigan, Gerald Paul (Rollins College), Maitland, Florida  
Moyer, Michael John (B.S., Albright College), Reading, Pennsylvania  
Myers, Gary Alan (B.B.A., DeLand University), Green Cove Springs, Florida  
Norcross, Elizabeth Jean (Duke University), Largo, Florida  
Oak, Steven Walter (B.S., Juniata College), Lancaster, Pennsylvania  
Pence, John Stephen (B.S., Davis and Elkins College), McGaheysville, Virginia  
Ross, Bruce Elliott (Franklin and Marshall College), Chatham, New Jersey  
Schliapin, Nicholas Peter (B.A., Gettysburg College), Washington, D.C.  
Schmit, David Anthony (B.A., Duke University), Auburn, Pennsylvania  
Seaman, John Peter (B.S., East Tennessee State University), Wilmington, Delaware  
Shelton, Lyle Wayne (Indiana Central College), Kennard, Indiana

Solomon, Kenneth Ira (B.A.; M.Ed., University of Cincinnati), Cincinnati, Ohio  
 Suppiger, Gerhart Schott III (B.A., Duke University), Belleville, Illinois  
 Surrency, Ellen Gwinn (B.S., Duke University), Media, Pennsylvania  
 Taaffe, Kenneth Edward, Jr. (B.A., Duke University), Trenton, New Jersey  
 Taal, Bye-Mass Max (B.A., Dartmouth College), Gambia, West Africa  
 Teese, Paul Stewart (B.A., Gettysburg College), Baldwin, New York  
 Timmons, Steven Craig (B.S., Elizabethtown College), North Wales, Pennsylvania  
 Todd, Robert Powell (Duke University), Kinnelon, New Jersey  
 Underhill, Roy Egerton (B.F.A., University of North Carolina, Chapel Hill), Washington, D.C.  
 Wehry, James Lamar (Albright College), Ashland, Pennsylvania  
 Wilson, Jan Robert (B.S., Miami University), Mount Vernon, Ohio  
 Yann, Ronald Jesse (Williamette University), Santee, California  
 Yohn, Cheryl Kay (B.S., Juniata College), Altoona, Pennsylvania  
 Zoltowski, Joseph Walter (Lycoming College), King of Prussia, Pennsylvania

#### Registered for the Master of Environmental Management Degree

Alexander, Lawrence Frederick (B.A., Duke University), Sanford, North Carolina  
 Applestein, Marc Brent (B.S., Duke University), Baltimore, Maryland  
 Baum, George Jürgen (B.A., University of North Carolina, Chapel Hill), Carrboro, North Carolina  
 Bickle, Gary Lee (Juniata College), Tyrone, Pennsylvania  
 Blakely, Carol Ann (B.A., Middlebury College), Canton, Massachusetts  
 Burns, Elizabeth Margaret (A.B., Mt. Holyoke College), Worcester, Massachusetts  
 Carlson, Tara Brook (Bridgewater College), Brandywine, Maryland  
 Carpenter, Kenneth Elton (Gettysburg College), Mt. Holly, New Jersey  
 Coffey, Stephen Dana (B.S., Elizabethtown College), Wellesley, Massachusetts  
 Cottingham, David (B.A., University of North Carolina, Chapel Hill), Greenville, South Carolina  
 Davis, Jean Ellen (B.A., St. Joseph College; M.A., Fairfield University), Watertown, Massachusetts  
 Deyle, Robert Eaton (A.B., Dartmouth College), Jacksonville, Florida  
 Dunn, William George (A.B., Duke University), Durham, North Carolina  
 Fausold, Charles James (B.A., Gettysburg College), Seneca Falls, New York  
 Faverty, Thomas Lee (B.A., Duke University), Plantation, Florida  
 Feltman, John David (B.S., West Georgia College), Mableton, Georgia  
 Flaherty, Mark Matthew (B.S., Clarkson College), Norwood, Massachusetts  
 Gruber, Peter Jonathan (B.A., Syracuse University), Sea Cliff, New York  
 Hale, Stephen Scot (Juniata College), Lafayette Hill, Pennsylvania  
 Hediger, Eric Myles (B.A., Rutgers University), Weston, Massachusetts  
 Helton, Stephen Clinton (B.A., Wake Forest University), Gastonia, North Carolina  
 Jakubowicz, Steven Paul (B.A., Franklin and Marshall College), Fair Haven, New Jersey  
 Koplin, Frederick Edward (B.S., Northwestern University), Atlanta, Georgia  
 Lee, Dora Yuen-kie (B.A., Princeton University), Flushing, New York  
 Lesesne, John Webb (B.S., Wake Forest University), Spartanburg, South Carolina  
 Lillie, Diane Louise (B.A., Skidmore College), Milwaukee, Wisconsin  
 Martin, Karen Sue (B.S., Illinois Wesleyan University), Galesburg, Illinois  
 Mayo, Tracy Lee (B.A., Duke University), McLean, Virginia  
 Metzger, John Bradley (B.S., West Virginia Wesleyan College), LaVale, Maryland  
 Niese, Jeffrey Halstead (B.S., Williams College), Roseland, New Jersey  
 Northup, James Michael (B.S., Wake Forest University), Minnville, New York  
 Palmer, Walter Arthur (B.S., Juniata College), Sharon, Massachusetts  
 Pappalardo, Peter Eric (B.S., Juniata College), Stroudsburg, Pennsylvania  
 Pelland, Kirk Patrick (A.B., Duke University; A.B., University of Akron), Akron, Ohio  
 Plott, David Michael (Franklin and Marshall College), Towson, Maryland  
 Rader, Charles Whitener (B.A., Duke University), Durham, North Carolina  
 Rosenfeld, William Spencer (B.S., Tulane University), Parma, Ohio  
 Sullenger, Karen Sue (B.S., Towson State College; M.S., Morgan State College), Hampstead, Maryland  
 Weitzel, Pamela Lynn (A.B., Mount Holyoke College), Springfield, Pennsylvania  
 White, Mary Ellen (B.A., Duke University), Coral Gables, Florida  
 Whiteside, Muriel Grant (B.S., Duke University), Old Greenwich, Connecticut  
 Worthington, Thomas Charles (A.B., Duke University), Princeton, New Jersey



### Students in the Department of Forestry and Environmental Studies in the Graduate School

Airola, Tervro Mathias (B.S.; M.C.R.P.; M.S., Rutgers University), Dover, New Jersey  
Barnard, Edward Livingston (B.S., University of Vermont; M.S., Duke University), Shoreham, Vermont  
Binstock, David Aaron (A.B., Hunter College; M.S., University of Michigan), Bronx, New York  
DeNitto, Gregg Allan (B.A., Thiel College), Glen Burnie, Maryland  
Duda, Alfred Michael (B.S., Boston College), Pittsfield, Massachusetts  
Gollob, Lawrence (B.S., State University of New York, Stonybrook), Yonkers, New York  
Keenan, Russell Edward (B.S., Bates College), Bradford, Connecticut  
Lorimer, Craig Gordon (B.A., Colby College), North Windham, Maine  
Meadors, Merewyn Davis (B.S.; B.A., Morris Harvey College; M.S., Marshall University), St. Albans, West Virginia  
Methven, Ian Robert (B.Sc.F., University of New Brunswick), Fredricton, New Brunswick, Canada  
Mowry, Fred Lear (B.S., Syracuse University), Syracuse, New York  
Nguyen Van Phu (For. Eng., College of Forestry, Viet Nam; M.F., Duke University), Saigon, Viet Nam  
Nichols, Rosemary (B.A., Randolph-Macon College; M.S., University of Michigan, Ann Arbor), Chatham, Virginia  
Péché, Gyula (B.S.F., University of British Columbia; M.F., Yale University; M.Sc., University of Guelph), Ottawa, Ontario, Canada  
Roberts, Stephen Winston (B.S., M.S., San Diego State University), La Jolla, California  
Robbins, Mary Kathryn (B.A., Denison University), Westport, Connecticut  
Saunders, Paul Richard (B.S.; M.S., Purdue University), Kokomo, Indiana  
Shaffer, Mark Leslie (B.S., Indiana University of Pennsylvania), Mahaffey, Pennsylvania  
Sigmon, John Thomas (A.B., Duke University), Charlotte, North Carolina  
Vasievich, Joseph Michael (B.A., Franklin and Marshall College; M.F., Duke University), Eaton, Pennsylvania





## DEGREES CONFERRED 1975-1976

### Master of Forestry

David L. Allen  
John Asprey Crew  
Bruce Robert Fraedrich  
John Hennessy Ghent  
Theodore S. Howard  
John Ramsey Johansen  
Edward Leonard Johnson  
Robert John McKimm  
Edward Paul McNamara  
Francis Arthur Rathburn  
Noel Frank Schneeberger  
Daniel Jay Schweitzer

Gary Iorwerth Seiler  
Mark Baldwin Shasby  
Victor Balmer Shelburne III  
David James Skove  
Phillip Gregory Smith  
Raymond Ralph Stoner  
John Jarrell Stuart  
Edward C. Thompson  
Daniel B. Twardus  
Roger Stuart Webb  
Eric H. Wharton  
Jon Stephen Wilson

### Master of Environmental Management

Patrick William Boyd  
Lincoln Curtis Fish  
Mark Whipple Oakman  
John Nicholas Rabbetts  
Janet Ophelia Kilby Rader

Carol Ann Simmermacher  
Stuart Gage Smith  
Helen Alice Stevenson  
Richard Treherne Tolley, Jr.  
Geoffrey S. Willett

### Master of Science

Mary Kathryn Robbins

### Master of Arts

Steven Gilbert Rush

### Doctor of Philosophy

Maynard Elwin Bates (B.A., Ohio University; M.S., Rutgers University), Dissertation: "Growth Responses to Containerized Southern Pine Seedlings to Temperature and Light in Controlled-Environment Greenhouses."

John McPherson Cheeseman (B.S., Duke University), Dissertation: "An Electrophysiological Investigation of Leaf Cells of *Lycopersicon esculentum*: With Particular Reference to the Action of Ricca's Factor."

Charles Edward Cordell (B.S., North Carolina State University; M.F., Duke University), Dissertation: "The Biology of *Cylindrocladium* spp. in Southern Forest Tree Nurseries."

Ingrid Christine Olmsted (B.S., Brandeis University), Dissertation: "Environmental Factors Influencing the Distribution of Two Species of *Phyllodoce* in the Mountains of Western North America."









# Bulletin of Duke University

Summer Session

1977





# Bulletin of Duke University

Summer Session

1977

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# Officers of the University Administration

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Roscoe R. Robinson, M.D., *Associate Vice President for Health Affairs and Chief Executive Officer of Duke Hospital*

Frederick C. Joerg, M.B.A., *Assistant Provost for Academic Administration*

Anne Flowers, Ed.D., *Assistant Provost for Educational Program Development*

William J. Griffith, A.B., *Assistant Provost and Dean of Student Affairs*

William C. Turner, Jr., M.Div., *Assistant Provost and Dean of Black Affairs*

Richard L. Wells, Ph.D., *Assistant Provost and Associate Dean of Trinity College of Arts and Sciences*

Joel L. Fleishman, LL.M., *Vice Chancellor for Public Policy Education and Research; Director of Institute for Policy Sciences and Public Affairs*

Connie R. Dunlap, A.M.L.S., *Librarian*

William E. King, Ph.D., *University Archivist*

Clark R. Cahow, Ph.D., *University Registrar*

Robert N. Sawyer, Ed.D., *University Educational Planning Officer and Director of Summer Educational Programs*

Rufus H. Powell, LL.B., *Secretary of University*

Charles Linn Haslam, J.D., *University Counsel*

## Officers of the Summer Session

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Paul D. Williams, Jr., Ph.D., *Assistant Director of the Summer Session*

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Ruby L. Wilson, R.N., Ed.D., *Dean of the School of Nursing*

Aleksandar Vesić, D.Sc., *Dean of the School of Engineering*

Richard L. Wells, Ph.D., *Assistant Provost and Associate Dean of Trinity College of Arts and Sciences*

William J. Griffith, A.B., *Assistant Provost and Dean of Student Affairs*

William C. Turner, Jr., M.Div., *Assistant Provost and Dean of Black Affairs*

Virginia S. Bryan, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*

Clark R. Cahow, Ph.D., *Director of Undergraduate Admissions*

Jane Monroe, B.S.N., *Associate Director of Continuing Education*

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Richard L. Cox, B.D., Th.M., *Associate Dean of Student Affairs*

James Douthat, B.D., *Associate Dean of Student Affairs*

John Cromer, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*

Rhett T. George, Jr., Ph.D., *Assistant Dean of the School of Engineering*

Shirley Hanks, A.B., *Career Counselor*

Dorothy J. Brundage, M.N., *Coordinator of the Undergraduate Academic Program of the School of Nursing*

JoAnne Hall, M.S.N., *Coordinator of the Graduate Academic Program of the School of Nursing*

Elaine T. Nagay, B.A., M.Ed., *Staff Assistant for Academic Affairs of the School of Nursing*

Elizabeth S. Nathans, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*

Jean F. O'Barr, Ph.D., *Director of Continuing Education*

Richard J. Rohlf, Ph.D., *Director of University Counseling Center*

Eleanor Bradsher, *Assistant to the Dean of the School of Nursing*

Ella E. Shore, M.R.E., M.A., *Dean of Student Affairs of the School of Nursing*

Howard A. Strobel, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*

Gerald L. Wilson, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*

Ellen W. Wittig, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*

Thomas A. Langford, Ph.D., *Dean of the Divinity School*  
 Benjamin Jayne, Ph.D., *Dean of the School of Forestry and Environmental Studies*  
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 William Katzenmeyer, Ed.D., *Associate Dean of the Graduate School*  
 John D. Costlow, Jr., Ph.D., *Director of the Duke Marine Laboratory*  
 Robert Young, B.D., *Minister to the University*  
 James Benjamin Smith, Jr., M.S.M., *Director of Chapel Music and Choral Music*  
 Walter Scott Persons, A.B., *Recreation Supervisor for the Summer Session*  
 Lawrence W. Smith, Jr., B.A., *Director of Housing Management*  
 Paul R. Benton, *Manager of Residence Halls*  
 Cecil Givens, B.A., *Manager of Apartments and Property*  
 Annie Royal Watson, *Administrative Secretary of the Summer Session*

## The Summer Session Faculty

Adams, Anne H., Ed.D., *Professor of Education*  
 Alt, Arthur Tilo, Ph.D., *Assistant Professor of German*  
 Bamford, Paul, Ph.D., *Visiting Assistant Professor of Philosophy*  
 Barber, Richard T., Ph.D., *Associate Professor of Zoology and Associate Professor of Botany*  
 Barnes, Robert D., Ph.D., *Visiting Professor of Biology*  
 Barnes, Robert Lloyd, Ph.D., *Professor of Forest Biochemistry*  
 Bassett, Frank H., III, M.D., *Professor of Orthopaedics*  
 Beecher, Robert, M.S., *Instructor in Anthropology*  
 Bessent, Helga W., M.A., *Assistant Professor of German*  
 Blanks, Mary M., M.H.A., *Assistant Professor of Health Administration*  
 Bolnick, Bruce R., Ph.D., *Visiting Assistant Professor of Economics*  
 Bookhout, C. G., Ph.D., *Professor of Zoology*  
 Bronfenbrenner, Martin, Ph.D., *William R. Kenan Professor of Economics*  
 Bryan, Anne-Marie, M.A.T., *Assistant Professor of Romance Languages*  
 Buehler, Albert G., M.A., *Associate Professor of Physical Education*  
 Butters, Ronald Richard, Ph.D., *Associate Professor of English*  
 Carbone, Peter F., Ed.D., *Associate Professor of Education*  
 Carson, Robert C., Ph.D., *Professor of Psychology*  
 Cartwright, William H., Ph.D., *Professor of Education*  
 Cell, John, Ph.D., *Associate Professor of History*  
 Chaiken, Leon E., M.F., *Professor of Forest Management*  
 Charlesworth, James H., Ph.D., *Associate Professor in Religion*  
 Chordas, Thomas, M.A., *Instructor in Anthropology*  
 Clum, John, Ph.D., *Assistant Professor of English*  
 Colver, Robert Merle, Ed.D., *Associate Professor of Education*  
 Conti, Eugene, M.A., *Instructor in Anthropology*  
 Corless, Roger, Ph.D., *Assistant Professor of Religion*  
 Cummins, Gaylord, Ph.D., *Visiting Associate Professor in Health Administration*  
 Davis, Lucy T., Ed.D., *Associate Professor of Education*  
 DeLucia, Frank C., Ph.D., *Assistant Professor of Physics*  
 DeNeef, A. Leigh, Ph.D., *Associate Professor of English*  
 Di Bona, Joseph, Ph.D., *Associate Professor of Education*  
 diCorcia, Joseph, Ph.D., *Assistant Professor of History*  
 Duffy, Bernard I., Ph.D., *Professor of English*  
 Duke, Kenneth Lindsay, Ph.D., *Associate Professor of Anatomy*  
 Durden, Robert F., Ph.D., *Professor of History*  
 Eckerman, Carol O., Ph.D., *Assistant Professor in Psychology*  
 Efird, James, Ph.D., *Associate Professor of Biblical Languages and Interpretation*  
 Eldridge, Albert F., Ph.D., *Assistant Professor of Political Science*  
 Evans, Lawrence E., Ph.D., *Associate Professor of Physics*  
 Falcone, David J., Ph.D., *Assistant Professor of Health Administration*  
 Flowers, Anne, Ed.D., *Professor of Education*  
 Forward, Richard B., Ph.D., *Assistant Professor of Zoology*  
 Fowle, Wallace, Ph.D., *James B. Duke Professor of Romance Languages*  
 Friedrich, John, Ph.D., *Professor of Physical Education*  
 Garci-Gómez, Miguel, Ph.D., *Associate Professor of Romance Languages*  
 Gehman, W. Scott, Jr., Ph.D., *Professor of Psychology in Education*  
 Githens, Sherwood, Ph.D., *Professor of Education*  
 Glaeser, J. Douglas, Ph.D., *Adjunct Assistant Professor in Geology*  
 Goalstone, Clifford, Ph.D., *Visiting Professor in Economics*

Goll, Robert, Ph.D., *Adjunct Associate Professor in Geology*  
 Gordon, Joseph, Ph.D., *Visiting Instructor in History*  
 Gunsburg, Jeffrey, Ph.D., *Visiting Assistant Professor in History*  
 Gutknecht, John W., Ph.D., *Associate Professor of Physiology and Pharmacology*  
 Halperin, David, Ph.D., *Visiting Professor in Religion*  
 Hamilton, Ruth, M.A., *Instructor in Anthropology*  
 Hanks, John, M.A., *Professor of Music*  
 Harris, Betty P., M.F.N., *Lecturer in Nursing*  
 Harvey, William John, M.Ed., *Assistant Professor of Physical Education*  
 Henry, James D., M.M., *Assistant Professor of Music*  
 Heron, S. Duncan, Ph.D., *Professor of Geology*  
 Hogue, Carol C., Ph.D., *Assistant Professor of Nursing and Assistant Professor of Community Health Sciences*  
 Holsti, Ole R., Ph.D., *George V. Allen Professor of Political Science*  
 Hull, Alexander, Ph.D., *Associate Professor of Romance Languages*  
 Hummer, Patricia, Ph.D., *Instructor in History*  
 Jackson, Wallace, Ph.D., *Associate Professor of English*  
 Jones, Buford, Ph.D., *Associate Professor of English*  
 Kalat, James, Ph.D., *Assistant Professor of Psychology*  
 Kerr, Robert B., Ph.D., *Professor of Electrical Engineering*  
 Klables, Gunter, Ph.D., *Visiting Professor of German*  
 Kort, Wesley A., Ph.D., *Associate Professor of Religion*  
 Kruzel, Joseph, Ph.D., *Assistant Professor of Political Science*  
 Lakin, Martin, Ph.D., *Professor of Medical Psychology in Department of Psychiatry and Professor of Psychology*  
 Leach, Richard, Ph.D., *Professor of Political Science and Lecturer in Education*  
 LeBar, John, Ed.D., *Assistant Professor of Physical Education*  
 Lehane, Steven, Ed.D., *Assistant Professor of Education*  
 Lockhead, Gregory, Ph.D., *Professor of Psychology*  
 Martin, David V., Ed.D., *Associate Professor of Education*  
 Mauskopf, Seymour, Ph.D., *Associate Professor of History*  
 McClay, David R., Ph.D., *Assistant Professor of Zoology*  
 Meyers, Eric M., Ph.D., *Associate Professor of Religion*  
 Mishler, William T., Ph.D., *Assistant Professor of Political Science*  
 Mitchell, Thomas G., Ph.D., *Assistant Professor of Microbiology*  
 Monroe, Robert, Ph.D., *Visiting Professor in Zoology*  
 Monsman, Gerald C., Ph.D., *Associate Professor of English*  
 Mueller, Julia W., M.A., *Professor of Music*  
 Myers, Roderick W., M.A., *Instructor in Physical Education*  
 Nathans, Sydney, Ph.D., *Associate Professor of History*  
 Ness, Gary, Ph.D., *Visiting Assistant Professor in History*  
 Nygard, Holger O., Ph.D., *Professor of English*  
 Oates, John F., Ph.D., *Professor of Ancient History in Classical Studies*  
 O'Barr, Jean F., Ph.D., *Lecturer in Political Science*  
 Osborn, Robert T., Ph.D., *Professor of Religion*  
 Palmer, Richard A., Ph.D., *Associate Professor of Chemistry*  
 Parker, Scott, M.A., *Managing Director of Duke Players and Technical Director of Duke Drama Program*  
 Partin, Harry B., Ph.D., *Associate Professor of Religion*  
 Patrick, Merrell Lee, Ph.D., *Associate Professor of Computer Science*  
 Persons, Walter S., A.B., *Associate Professor of Physical Education*  
 Peterson, Ingo, Ph.D., *Professor in Chemistry*  
 Pilkey, Orrin, Ph.D., *Professor of Geology*  
 Pittillo, Robert A., Jr., Ed.D., *Associate Professor of Education*  
 Pratt, Sheila, *Instructor in Art*  
 Pratt, Vernon, M.F.A., *Assistant Professor of Art*  
 Preiss, Jack J., Ph.D., *Professor of Sociology*  
 Price, David Eugene, Ph.D., *Associate Professor of Political Science and Associate Professor of Policy Sciences*  
 Price, James L., Jr., Ph.D., *Professor of Religion*  
 Reardon, Kenneth, M.A., *Associate Professor of English*  
 Reiss, Edmund, Ph.D., *Professor of English*  
 Riebel, John D., M.A., *Assistant Professor of Physical Education*  
 Ripley, Dana P., Ph.D., *Associate Professor of Romance Languages*  
 Ritz, Michael, B.S., *Lecturer in Physical Education*  
 Roberts, George W., Ph.D., *Associate Professor of Philosophy*  
 Robinson, Hugh G., Ph.D., *Professor of Physics*



Rosen, Lawrence, Ph.D., *Associate Professor of Anthropology*  
 Rosendahl, Bruce R., Ph.D., *Assistant Professor of Geology*  
 Ross, Russell, M.A., *Instructor in Economics*  
 Rowe, Gilbert T., Ph.D., *Visiting Professor in Zoology*  
 Sanford, David, Ph.D., *Associate Professor of Philosophy*  
 Santi, Enrico-Mario, M.Ph., *Instructor in Romance Languages*  
 Sawyer, Robert L., Ed.D., *Associate Professor of Education*  
 Searles, Richard B., Ph.D., *Associate Professor of Botany*  
 Shuman, R. Baird, Ph.D., *Professor of Education*  
 Simpson, Ida H., Ph.D., *Associate Professor of Sociology*  
 Skinner, Leroy C., M.A., *Associate Professor of Physical Education*  
 Smith, Grover C., Ph.D., *Professor of English*  
 Smith, Peter, Ph.D., *Professor of Chemistry*  
 Spragens, Thomas A., Jr., Ph.D., *Associate Professor of Political Science*  
 Strandberg, Victor H., Ph.D., *Associate Professor of English*  
 Sullivan, James B., III, Ph.D., *Assistant Professor of Biochemistry*  
 Sutherland, John P., Ph.D., *Assistant Professor of Zoology*  
 Wachtel, Howard, Ph.D., *Associate Professor of Biomedical Engineering and Assistant Professor of Physiology*  
 Ward, Calvin L., Ph.D., *Associate Professor of Zoology*  
 Warner, David M., Ph.D., *Assistant Professor of Health Administration*  
 Weintraub, E. Roy, Ph.D., *Associate Professor of Economics*  
 White, Eleanor, M.S., *Assistant Professor of Nursing*  
 White, Fred M., M.F., *Assistant Professor of Silviculture*  
 White, Richard Allen, Ph.D., *Professor of Botany*  
 Wilder, Pelham, Ph.D., *Professor of Chemistry*  
 Williams, George W., Ph.D., *Professor of English*  
 Wilson, John, Ph.D., *Associate Professor of Sociology*  
 Wintermute, Orval S., Ph.D., *Associate Professor of Religion*  
 Withers, Loren R., M.S., *Professor of Music*  
 Wolbarsht, Myron L., Ph.D., *Adjunct Professor of Biomedical Engineering, Adjunct Associate Professor of Physiology, and Lecturer in Psychology*  
 Wyse, Allen, Ph.D., *Assistant Professor of Economics*  
 Yohe, William P., Ph.D., *Professor of Economics*

# General Information





## The Summer Program at Duke

The summer session at Duke University makes available to Duke students, to students from other universities and colleges, to teachers in elementary and secondary schools, and to other special students a notable program of instruction in many fields of knowledge, both academic and professional. Course programs offered during the summer are designed to meet special and particular needs as well as the more conventional requirements leading to specific degrees.

Postdoctoral research scholars may find the regular summer session courses useful for further study. The library facilities and the various laboratories may be valuable for postdoctoral residents. Graduate students who have been admitted to the Graduate School to study for the Master of Arts, Master of Education, and Master of Arts in Teaching degrees will find courses arranged in sequence from summer to summer to meet their requirements. Teachers from elementary and secondary schools who desire to earn credits toward the renewal of their certificates and who are interested in further teacher training in subject content and method may enroll in senior-graduate courses as special or unclassified students. Undergraduates of Duke University who desire to accelerate their programs may complete the work for a degree in three years by attending two or more summer sessions. Undergraduates from other colleges and universities may enjoy the special advantages of summer instruction at Duke and transfer credits earned to their own institutions.

Although the summer course program meets, in many departments, the needs of degree candidates, it goes beyond these limits in also presenting courses of wide general interest and, in addition, special non-credit lectures, conferences, institutes, and workshops. The ample and modern research facilities of Duke University will be available during the summer to all properly qualified students. It is the hope of the University, of the summer faculty, and of the administrative officers that former students and new students will find increasing value in each summer spent at Duke.

### Policy of Nondiscrimination

Duke University does not discriminate on the basis of race, color, national and ethnic origin, or sex, in the administration of educational policies, admission policies, financial aid, employment, or any other university program or activity. It admits qualified students of any race, color, sex, national and ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students.

# Program Information







## Undergraduate Study

Students in the undergraduate college and schools of Duke University who desire to enrich or accelerate their academic study will find summer programs to meet their individual needs and interests. Special courses are provided which are not otherwise available to undergraduates; election of the usual courses may relieve an overload during the fall or spring terms. Summer programs also enable some students to attain provisional graduate status in the senior year or to graduate in less than four years.

By attending at least two terms of the summer session, it is possible for a student to earn credit for as many as four semester-courses. Instruction will be offered in the summer of 1977 in most departments and colleges. Specific requirements for degrees offered in the undergraduate colleges and schools may be obtained from the *Bulletin of Undergraduate Instruction*.

## Divinity School Studies

Degrees of Master of Divinity and Master of Religious Education are administered by the faculty of the Divinity School. Students in these programs may register with the Summer Session Office for independent study in any one of the terms of the summer session or for the language courses which are listed under the heading Divinity School in this *Bulletin*. Persons desiring credit toward one of these degrees must be regularly admitted to the Divinity School and all courses taken by the student for Divinity School credit must be registered and approved by the Associate Dean for Curricular Affairs in the Divinity School.

## Graduate Study

**Degrees and Requirements.** The Graduate School of Duke University now offers the following degrees: Master of Arts (A.M.), Master of Science (M.S.), Master of Education (M.Ed.), Master of Arts in Teaching (M.A.T.), Master of Health Administration (M.H.A.), Doctor of Education (Ed.D.), and Doctor of Philosophy (Ph.D.). Specific requirements relative to admission, residence, major and related studies, languages, and thesis requirements may be obtained from the *Bulletin of the Graduate School*.



Candidates for degrees in the Graduate School desiring to have their degree conferred on September 1 must have completed all requirements for the degree as of the final day of the Duke University summer session. Candidates who complete degree requirements at the end of the fall semester receive diplomas dated September 1. Graduation exercises are held once a year in May when degrees are conferred and diplomas issued to those who have completed requirements by the end of the spring semester. There is a delay of about one month in the mailing of September and December diplomas because diplomas cannot be issued until they are finally approved by the Academic Council of the Board of Trustees.

**Unclassified Graduate Students.** Any student who holds an A.B. or B.S. degree and who does not intend to earn an advanced degree at Duke University but who desires graduate work for professional or other reasons should apply to the Director of the Summer Session for admission as an unclassified student. Credits earned by an unclassified student in graduate courses taken at Duke before admission to the Graduate School may be carried over into a graduate degree program if (1) the action is recommended by the student's director of graduate studies and approved by the Dean, (2) the work is not more than two years old, (3) the amount of such credit does not exceed 6 units, and (4) the work is of *G* level or better.

**Cooperative Program in Teacher Education.** Selected graduates of liberal arts colleges who desire to prepare for high school teaching will be admitted to a special internship program at Duke University. This program is designed for selected college graduates who did not prepare professionally for teacher certification as undergraduates. The cooperative program provides for selected candidates graduate study in their special fields, professional courses, and carefully supervised observation and teaching experiences. One who completes the program successfully can achieve, within a period of fifteen months, a year of teaching experience, a Master of Arts of Teaching degree, and full certification as a teacher.

Candidates will begin the program at the opening of Term II of the 1977 summer session and complete it in August, 1978. They will spend two terms of the summer preceding and the summer following the year of teaching in residence at the University. During the school year 1977-1978 interns will be employed as regular teachers in cooperating public and private school systems. During this year they will receive full salary and will work under the joint supervision of the cooperating school and the University. The program will meet training qualifications for the advanced or graduate teacher's certificate in many states. Participants in the program are encouraged to teach for a second year as full certified teachers in the school in which they complete the internship.

The salary for the year of teaching will, in effect, constitute a substantial award to candidates selected for the program. Interns will benefit from the special tuition rate for teachers. Applicants will be considered, as are candidates for other awards, on a competitive basis. The best qualified applicants will be chosen on the basis of undergraduate record, recommendations, and evidence of interest in becoming high school teachers. It is suggested that applicants arrange interviews in connection with their applications. Application forms and details concerning the program can be obtained by writing the Director, Cooperative Program in Teacher Education, Department of Education, West Duke Building, Duke University. Application forms should be submitted before February 1, 1977.

## **Graduate School of Business Studies**

The Graduate School of Business offers a Master of Business Administration (M.B.A.) and a Master of Management (M.M.). Combined undergraduate-professional programs are available for eligible students. Specific requirements for degrees and admission may be obtained from the *Bulletin of the Graduate School of Business Administration*.

## **Postdoctoral Research**

Scholars engaged in postdoctoral research find it advantageous and sometimes essential to use the resources of the Duke University libraries during the summer. The University welcomes these visitors and makes living accommodations (dormitory space and dining facilities) available to them during the summer sessions from May 10 to August 19, 1977.



# Special and Cooperative Programs







## Cooperative Program

The long standing reciprocal agreement between Duke and the University of North Carolina is now effective for the summer sessions at both universities. To take advantage of this arrangement for either term of the summer session, the student registers each term for 3 units of credit at the home institution and 3 units representing the course to be taken at the other institution, for a total of 6 units. Credit so earned is not defined as transfer credit. This program applies to both graduate and undergraduate students.

## Special Conferences and Courses

**Special Programs for Teachers of Science and Mathematics.** It is anticipated that the summer session will offer a number of special programs at the graduate level designed specifically for high school teachers of science and mathematics. For detailed information on the programs, teachers should write Dr. Sherwood Githens, Department of Education, Duke University, Durham, North Carolina 27708.

**Highlands Biological Station.** Duke University holds a subscribing instructional membership in the Highlands Biological Station at Highlands, N. C., on the southern edge of the Blue Ridge Mountains at an elevation of 4,118 feet. The situation and the region offer an excellent opportunity for field studies and some laboratory work. A limited number of qualified students in botany and zoology may make arrangements to carry out research at this station.

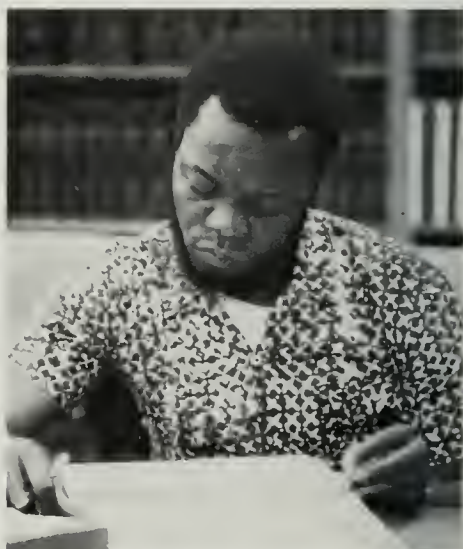
**Medical Mycology.** A comprehensive course in medical mycology is offered during the month of July at the Duke University Medical Center. The class will meet daily, Monday through Friday, beginning on July 5 and ending July 29, 1977.

The laboratory will be a major part of the course, and it will concentrate on the practical identification of both saprophytic and pathogenic fungi. Students will participate in all aspects of diagnostic mycology from the collection of patient specimens and identification of organisms, through fungal serology and record-keeping. The lecture material will survey the mycology, immunology, pathogenesis, and epidemiology of all the pathogenic fungi. Several internation-

ally recognized mycologists will be invited as guest lecturers to meet with students and discuss their particular areas of expertise and current research interests.

The enrollment for the course will be limited to twenty students, and applications will be considered in the order received. A fee of \$200 will be charged for this course; alternatively, a student may register in the summer session, pay the tuition required and receive 4 units of graduate credit for the course. All inquiries should be addressed to Dr. Thomas G. Mitchell, Department of Microbiology and Immunology, Duke University Medical Center, Durham, N. C. 27710.

**The Ministerial Course of Study School.** In cooperation with the Board of Education and the Southeastern Jurisdictional Conference of the United Methodist Church, Professor Paul A. Mickey directs the Ministerial Course of Study School. This is not related to the regular Divinity School degree program, and no credit toward a seminary degree can be earned. The twenty-ninth session of the school is from June 27 to July 22. For further information write the Director, Box 4484, Duke Station, Durham, N. C. 27706.



**Divinity School Institute for Ministry.** Seminars and clinics, running concurrently, for ministers, wives, and church leaders of all denominations will be conducted at the Duke Divinity School May 9-13 and May 16-20, 1977. These are designed to supplement seminary education through one or two weeks of intensive training in academic and professional studies. No academic credit is given.

Sponsoring institutions make funds available for tuition. Other scholarships are available upon request. For full information write the Director of Continuing Education, Duke Divinity School, Durham, N. C. 27706.

**Summer Drama Program.** The Duke University Drama Program offers theater-oriented students and teachers an integral program of training in theater and dramatic literature during the first and second summer sessions.

The courses in practical theater, taught by members of the professional staff of Summer Theater at Duke, will offer formal instruction and supervision in all aspects of theatrical production. In addition, a group of related courses in dramatic literature will offer the student a close study of the great plays of the past and present.

For further information see the course listings in Drama. Detailed information on faculty, courses, productions, and auditions for Summer Theater at Duke may be obtained by writing Box 6936, College Station, Durham, N. C. 27708.

**Southeastern Institute of Medieval and Renaissance Studies.** Participation in the Southeastern Institute of Medieval and Renaissance Studies is open to those with scholarly interest in all areas of medieval and Renaissance studies, including (among others) art, aesthetics, history, literature, music, paleography, philosophy, and religion. The institute consists of six informal seminars, each concerned with a topic of interest to students of the medieval and Renaissance periods. Each seminar is led by a senior fellow and has an enrollment of about six participants, designated as fellows. Each fellow participates in one seminar and has ample time to devote to individual research. It is emphasized that the seminars are not courses but informal meetings to encourage the exchange of ideas and to stimulate participants in their own research. In most cases fellows will be beyond the Ph.D. level, but in some cases applications will be considered from advanced graduate students.

The public is invited to attend a series of lectures on medieval and Renaissance topics during each session of the institute.

Annually the institute alternates between the campuses of Duke University and the University of North Carolina at Chapel Hill. The ninth session will be held on the Chapel Hill campus.

**Loblolly.** The summer performing arts workshop, with an emphasis on dance, is dedicated to the ideal of self-realization through the creative experience. Beginning to advanced students of movement can choose from a variety of disciplines and techniques—modern, ballet, jazz, tap, mime, movement in theatre, multi-media, composition, theory, production—and are encouraged to create their own works and perform. The staff of professional artists will include a modern dance company in residence. Loblolly guest artists and students will perform at Duke and through the Research Triangle community as guests of other performing arts programs. For more information write Loblolly, Box 6086, College Station, Durham, North Carolina 27708.



# Resources for Study





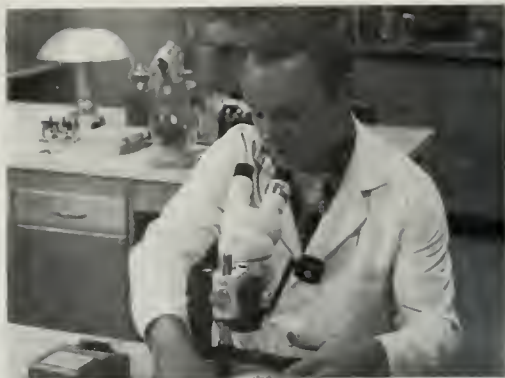


## University Libraries

**The Library System.** The libraries of the University consist of the Perkins Library and its eight branches on campus: Biology-Forestry, Chemistry, Divinity, East Campus, Engineering, Music, Physics-Mathematics, and Undergraduate; and the Pearse Memorial Library at the Duke Marine Laboratory in Beaufort; the Law Library; and the Medical Center Library. In June, 1976, these libraries contained approximately 2,700,000 volumes and ranked eighteenth in size among academic libraries in the United States. More than 14,000 periodicals, 20,000 serials, and 200 newspapers are received regularly. The collection includes about 5,000,000 manuscripts, 70,000 maps, 28,000 sheets of music, and 235,000 rolls or sheets of microtext.

*The William R. Perkins Library*—the main library of the University—houses most of the books and journals in the humanities and social sciences, large files of United States federal and state documents, public documents of many European and Latin American countries, publications of European academies and learned societies, and special collections from South Asian, Far Eastern, and Slavic countries. The newspaper collection, with 15,000 volumes and 30,000 reels of microfilm, has several long eighteenth-century files, strong holdings of nineteenth-century New England papers and antebellum and Civil War papers from North Carolina, South Carolina, and Virginia as well as many European and Latin American papers. The manuscript collection of approximately 5,000,000 items is particularly strong in all phases of the history, politics, and social and economic life of the South Atlantic region, and includes significant papers in English and American literature. The rare books collection contains many scarce and valuable materials covering a broad range of fields. The collection of Latin and Greek manuscripts constitutes one of the outstanding collections of its kind in the United States. The collection of Confederate imprints is the largest in the country.

The Undergraduate Library houses a small collection of books designed to meet the needs of undergraduates and serves as a center for the required reading materials placed on reserve for undergraduate courses. The branch libraries serve the academic disciplines which their names bear. The East Campus Library is primarily for undergraduate use but also contains the principal collections for graduate and undergraduate study in art.



Tours of the Perkins Library are given frequently during Orientation Week and upon request throughout the year. Information about other campus libraries may be obtained from the staff in each of the libraries. Handbooks about library services and facilities are also available in each of the libraries.

*The School of Law Library.* The law library, with approximately 200,000 volumes, serves both the University and the local legal community. The collection contains nearly all reported decisions of the federal, state, and territorial courts of the United States, British Commonwealth, and representative foreign jurisdictions. It also includes the constitutions, codes, statutes, and subsidiary legislative publications of all of these jurisdictions as well as many digests, indexes, bibliographies, and related research tools. A large section of the library collection is devoted to treatises on all phases of law and legal sciences and works

in the field of history, economics, government, and other social and behavioral sciences relevant to legal research. There are files of selected federal documents, and since 1970 a complete set of Congressional materials has been maintained. The Christie Jurisprudence collection is located in the main reading room. Other areas of collection strength include legal history, administrative materials, intellectual property, criminal procedure, school law, and briefs of the U. S. Supreme Court, the Fourth Circuit Court of Appeals, and the North Carolina Supreme Court and Court of Appeals. Undergraduate students whose course of study requires access to the law literature are welcome to use the collections.

*The Medical Center Library.* Located in the Seeley G. Mudd Communications Center and Library Building on the medical campus, the Medical Center Library provides the services and collections necessary to further educational, research, and clinical activities in the medical field. Its services are available to the students, faculty, and staff of the Schools of Medicine, Nursing and Allied Health; Duke Hospital; and the Medical Center Graduate Departments. Other students and faculty needing access to the biomedical literature may apply for privileges upon application to the Chief of Readers' Services.

Over 160,000 volumes are available, including the Trent Collection in the History of Medicine. Approximately 2200 journal titles are received, plus extensive back files of older materials. The library has several types of audio-visual materials and equipment. With the exception of certain items shelved on reserve, these materials have been integrated into the general book and journal collections and are listed in the card or journal catalogues. The Frank Engel Memorial Collection consists of a small group of books on non-medical subjects for general reading, together with several newspapers and popular magazines. Traditional reference services are supplemented by on-line bibliographic systems and computer-produced specialized indexes. Borrowing privileges are uniform, and apply to all registered users. Details of loan and other services may be found in the guide published each year, available at the library.

## Laboratories

The laboratories in the various science departments (botany, chemistry, physics, psychology, and zoology) are designed for both teaching and research. Ideal locations for special work in some of the sciences are available at Duke University Marine Laboratory at Beaufort, North Carolina; at Highlands Biological Laboratory at Highlands, North Carolina; in the Duke Forest at Durham, North Carolina; and in the Sarah P. Duke Gardens on the West Campus of Duke University.



# Student Life







## Living Accommodations

Duke University provides residence hall accommodations on West Campus for graduate and undergraduate students enrolled in the summer session. Efforts are made to house all students in air-conditioned facilities, but because these are limited, use of non-air-conditioned facilities may become necessary.

Air-conditioned apartments are available for single students and married students accompanied by their families. Units in the new Central Campus Apartments and Town House Apartments will be used.

Information for each type of residential accommodation may be obtained by writing the appropriate manager whose address is found on page 25 in the chapter on Financial Information.

**Dining Service.** Food service is cafeteria style. The cost of meals depends on the needs and tastes of the individual. Only the dining facilities on the West Campus will be used for the regular summer session students. The cafeteria in the Graduate Center is usually not open in the summer.

**Duke University Marine Laboratory.** The Duke University Marine Laboratory, located on Pivers Island, has cottage-type residence halls which will be available for summer session students. Further information may be obtained from the *Bulletin of the Duke University Marine Laboratory*.

## Services Available

**Medical Care.** The Student Health Service, located in the Marshall I. Pickens Rehabilitation Center, operates during the summer session and, except for hospitalization in the University infirmary, offers the same medical and surgical services available to full-time students during the academic year as described in the *Bulletin of Information and Regulations*. Use of the Student Health Service is restricted to matriculating students. Presentation of a current student identification/enrollment card is required.

All students are charged a health fee for each summer term. See the section in this *Bulletin* on Tuition and Fees.

The Student Mental Health Service is located in the Pickens Rehabilitation Building on Erwin Road. The service provides evaluation, brief counseling, and treatment for matters ranging from questions about normal growth and de-

velopment to the most serious psychiatric disorders. Student Mental Health Service records are maintained separately and are not a part of any other record system, academic or medical. Contact with the service is strictly confidential. No illness is treated in dormitories or other student residence rooms.

Regular clinic services are available for use from 8 a.m. to 6 p.m., Monday through Saturday, at the University Health Clinic, Pickens Building, West Campus, phone 684-6721.

**The University Counseling Center.** The University maintains a University Counseling Center which provides a centralized program of educational, vocational, and personal counseling for students. This confidential counseling service on problems of personal, social, educational, and vocational adjustment is provided without cost to students enrolled at the University. In addition, the center administers special group testing programs for University schools and departments and serves as the local testing center for a wide variety of national testing programs. The center also carries on programs of research in the field of measurement and counseling. Although the counseling, testing, and research services of the center are designed primarily to meet the needs of the students, faculty, and staff of Duke University, these services are made available to individuals and organizations outside the University as its facilities permit. Requests for further information should be addressed to the Director, University Counseling Center, 309 Flowers, Duke University, Durham, North Carolina 27706.

**Office of Placement Services.** Duke University maintains an Office of Placement Services which acts as a liaison between the University and potential employers in business, education, and government. All services are offered without charge to students in the summer session who are registered for a degree at Duke University. The staff is available to talk with summer session students about their professional plans and with school officials who may be seeking the services of new teachers. Students who are eligible to register with the office are offered an opportunity to assemble a complete dossier of academic records and recommendations to supplement applications for positions and to have a permanent file for future reference. Pertinent recommendations should be accumulated during the time the student is enrolled at Duke.

Part-time employment listings for the campus and Durham area are maintained in the office. All students interested in working during the summer session should register at the beginning of the term. Every effort will be made to help each student find a job consistent with expressed interests.

## Student Activities

**Religious Life.** During the summer the Duke Chapel is open every day for prayer and meditation from 9:00 a.m. to 8:00 p.m. The Sunday morning worship in the Chapel at 11:00 a.m. is the central focus for the summer ministry. The University ministers and chaplains are available for assisting in planning programs and projects and for discussions and personal counseling.

**Recreation and Activities.** The summer session will provide a varied program of entertainment and recreation. The program includes movies, dances, and open house socials. Tours to areas of interest can be arranged for weekends. Both the mountains and the seashore are easily accessible. Adequate facilities are available for those interested in swimming, tennis, and other sports. Clubs organized for the summer play an active part in all social activities and recreation.

**Summer Theater at Duke.** For its sixth season, Summer Theater at Duke will offer six productions during a season which will run from May 20 to July 17.



Production schedules and season ticket information may be obtained at Page Box Office.

Interested students are invited to join the company or crew of Summer Theater at Duke. Auditions for all productions will be held on April 18 and 19 in 209 East Duke Building.

For further information, write Box 6936, College Station, Durham, North Carolina 27708.

## Publications

During the summer the University will publish each session *The Duke University Calendar*, an official calendar announcing events—academic, social, and recreational—of the following term. This calendar also includes official notices concerning academic requirements. Students are expected, therefore, to read the *Calendar* regularly.

## Conduct of Students

Duke University expects and will require of all its students continuing loyal cooperation in developing and maintaining high standards of scholarship and conduct.

The University wishes to emphasize its policy that all students are subject to the rules and regulations of the University currently in effect or which are, from time to time, put into effect by the appropriate authorities of the University. The student is expected to be familiar with the current *Bulletin of Information and Regulations* as well as any published regulations for the summer session.

Students, in accepting admission, indicate their willingness to subscribe to and be governed by these rules and regulations and acknowledge the right of the University to take such disciplinary action, including suspension and/or expulsion, as may be deemed appropriate, for failure to abide by such rules and regulations or for conduct adjudged unsatisfactory or detrimental to the University. University authorities will take action in accordance with academic due process.



# Admission







## Qualifications for Admission

Students in the following categories may be admitted to the Duke University Summer Session:

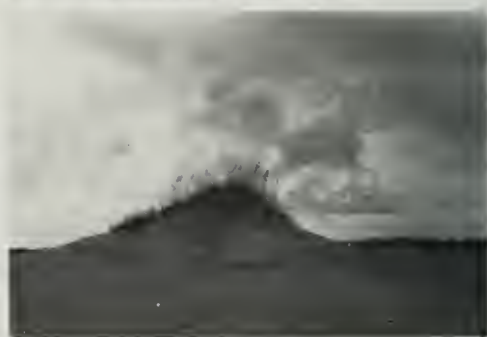
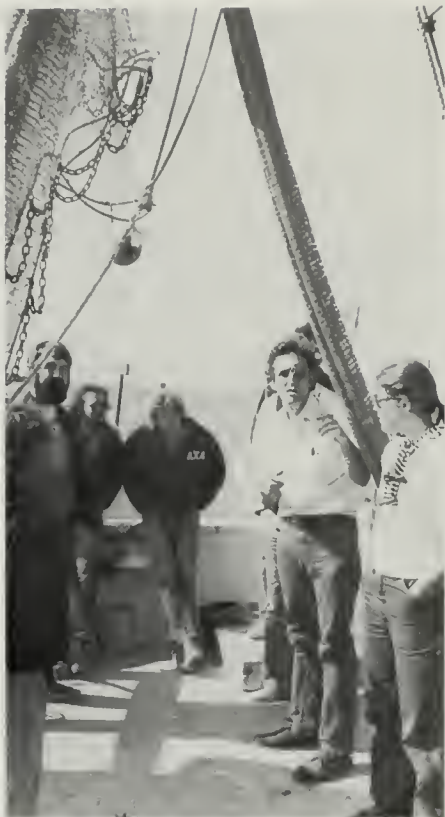
1. Graduates and undergraduates who are presently enrolled and in good standing in Duke University.
2. Graduates and undergraduates who have been formally admitted or readmitted to Duke University.
3. Students who are currently in good standing at their respective institutions and who have approval by the proper authority to take and transfer credits earned in the Duke Summer Session.
4. Teachers in service with or without the bachelor's degree who wish to earn credits for certification purposes.

Admission to specific courses offered in the summer session is governed by the student's academic status (freshman, sophomore, junior, senior, graduate, special, or unclassified) and by the prerequisites of the course in question. All applicants are considered without regard to race, color, religion, sex, or national origin.

## Application Procedures

**Duke Students in Residence during the Spring Semester, 1977.** A Duke University student, either graduate or undergraduate, who plans to attend the summer session should at the time of preregistration for the fall semester (see page 30 for specific dates) enroll for the desired summer session courses. The student need not file the application blank at the end of this *Bulletin* with the Summer Session Office.

**Undergraduates Not in Residence at Duke during the Spring Semester, 1977.** New students seeking to enter Duke University as freshmen or as undergraduates with advanced standing, and undergraduates who wish to reenter the University, should write the Office of Admissions requesting application forms.



Undergraduates, both men and women, enrolled in other colleges and universities who desire to earn in the Duke University summer session credits which are to be transferred to their own institutions should apply directly to the Director of the Summer Session, Duke University, on the application form at the end of this *Bulletin*. They should give accurately and clearly all information called for on the application form.

**Graduates Not in Residence at Duke during the Spring Semester, 1977.** Students who are seeking admission to the Graduate School and those who have been admitted to the Graduate School must apply to the Director of the Summer Session on the application form at the end of this *Bulletin*. Those who are seeking admission to the Graduate School must also file Graduate School application forms. These may be secured by writing to the Dean of the Graduate School, Duke University, Durham, North Carolina 27706.

Students who have graduate standing, who are currently employed as teachers, and who wish to earn credits toward renewal or the advancement of their certificate may enroll in the summer session as unclassified graduate students without becoming candidates for a degree at Duke University. Credits earned by unclassified graduate students in graduate courses at Duke may later be counted toward an advanced degree at Duke if the conditions stated on page 4 are met. All students in the unclassified category should apply to the Director of the Summer Session for admission. The application at the end of this *Bulletin* may be used.

**Postdoctoral Scholars.** Application for postdoctoral research privileges must be made in advance by letter to the Director of the Summer Session giving the applicant's present position, the specific field of research interest, and the dates during which residence is desired. Approved applicants will be accepted subject to the availability of library and dormitory space.

## Admission to Degree Candidacy

**Undergraduates.** A student seeking to enroll as a candidate for one of the advanced degrees offered by the Graduate School of Duke University must meet the requirement set forth in the *Bulletin of the Graduate School*. This *Bulletin* may be secured by writing to the Office of the Graduate School, Duke University, Durham, N. C. 27706.

**Graduates.** A student seeking to enroll as a candidate for one of the advanced degrees offered by the Graduate School of Duke University must meet the requirements set forth in the *Bulletin of the Graduate School*. This *Bulletin* may be secured by writing to the Office of the Graduate School, Duke University, Durham, N. C. 27706.

# Financial Information







## Tuition and Fees

**The University Tuition.** The following charges will cover registration and medical care:

1. Tuition for undergraduates—\$279 for each non-laboratory course, \$372 for each undergraduate laboratory course, and \$558 for each one and one-half course program offered at the Marine Laboratory.
2. Tuition for graduate students—\$93 per unit; for an undergraduate course, the tuition rate is as indicated in paragraph one above.
3. Teachers in full-time service in elementary and secondary schools, except teachers pursuing a doctoral program at Duke—one-half of the tuition charges specified in paragraphs one and two above.
4. All students pursuing a doctoral program at Duke (post-master's)—fees as specified in paragraphs one and two above.
5. All students are required to pay a \$14.50 health fee per term. Graduate students who are only in residence for Terms I, II, and III are required to pay \$21.75 which covers all three terms.

**Laboratory Fees.** For Marine Laboratory investigators' research table fee, see the *Marine Laboratory Bulletin*.

**Medical Mycology Fee.** This fee of \$200 replaces the University tuition.

**Master's Degree Summer Session Tuition.** A master's candidate who submits a thesis when not registered for at least 1 unit of research-residence tuition is required to pay the 1-unit tuition of \$93.

**Auditing Fees.** These fees are as follows:

1. Students registered for a full course program may audit non-laboratory courses (with the permission of the Director) at no extra charge.
2. Students carrying less than a full course program may be granted permission to audit a course but must pay half the University fee for the course.

**Late Registration Fee.** Students who fail to register prior to the first class day of a given course will pay an extra charge of \$25.

**Fee for Course Changes.** Course changes other than those required by the University will be made only on payment of an extra fee of \$1 per change.

**Fee for Make-up Final Examination.** This fee is \$5.

**Refund for Tuition and Fees.** Tuition and fees will be refunded under the following circumstances:

1. When applications for withdrawal are received by the Director of the Summer Session before the first class day of a given term of the summer session, full tuition and fees will be refunded.
2. When applications for withdrawal are received by the Director of the Summer Session during the first four class days of a given term, 80 percent of the tuition and fees will be refunded.
3. When applications for withdrawal are received by the Director of the Summer Session after the fourth class day, there will be no refund of tuition and fees.

**Debts.** No records are released and no student is considered by the faculty as a candidate for graduation until all indebtedness has been settled with the Bursar.

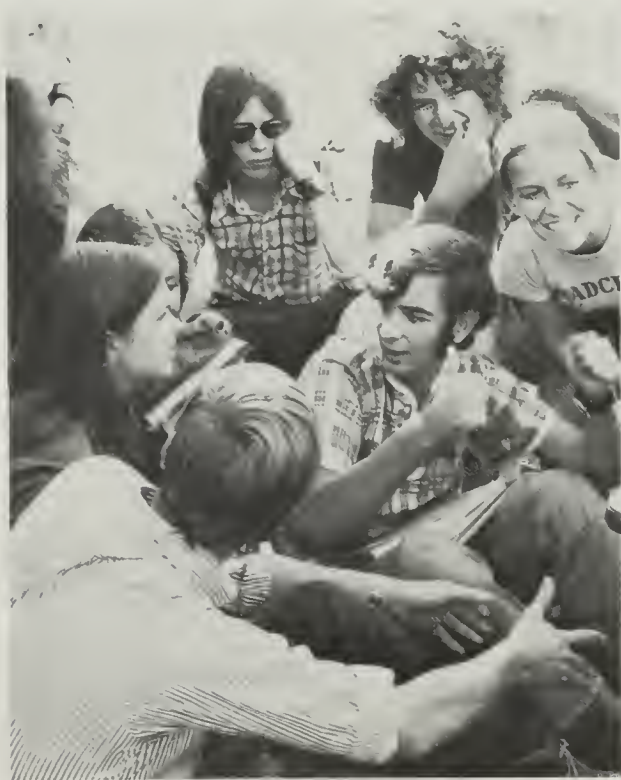
## Living Accommodations

### Rates for Residence Hall Space for Each Summer Term\*

	<i>All courses except Science and Medical Mycology</i>	<i>Science and Medical Mycology</i>
Single Occupancy†	\$135	\$116
Double Occupancy†	\$100	\$ 86

\*Rates for non-air-conditioned space when used will be somewhat lower.

†All prices are subject to change.



Rates for one, two, or three-bedroom apartments vary according to the type unit desired and the number of persons occupying the apartment. Linen rental service is available through the Student Laundry on West Campus. No housewares are available for use in apartments.

For detailed information on types of accommodations available at Duke University for the summer session write: (for residence halls), Manager of Residence Halls, Department of Housing Management, Duke University, Durham, N. C. 27706; (for apartments), Manager of Apartments and Property, Department of Housing Management, Duke University, Durham, N. C. 27706.

## Estimated Cost of One Term of the Summer Session

University tuition, two non-laboratory courses or 6 graduate units	\$558.00*
Health fee	14.50
Residence Hall fees (double room for one term)	100.00
Books and class materials (average)	30.00†
Miscellaneous (laundry, etc.)	20.00†
	<hr/>
	\$722.50

Meals are cafeteria style; costs will vary according to individual tastes and needs.

\*Teachers, elementary and secondary, in full-time service (except teachers pursuing a doctoral program at Duke) pay \$279.

†Approximate costs will vary according to individual needs.







## Student Aid

**Special Tuition Rate to Teachers.** Teachers in full-time service in elementary and secondary schools, except those who are pursuing a doctoral program at Duke, pay only one-half of the regular tuition charge. Teachers on leave of absence from their schools and teachers not currently employed are not eligible for this special fee.

**Scholarships for Public School Personnel.** Duke University will offer twenty special scholarships of \$279 each to high school and elementary teachers, supervisors, and administrators on a competitive basis (not by a written examination) for the summer session of 1977. This scholarship program is intended to encourage teachers, supervisors, and administrators to begin or continue their graduate studies leading to advanced degrees.

Although successful applicants for the scholarships will not be required to become candidates for a degree, they must qualify for, and receive admission to, the Graduate School.



All applications with supporting documents must be submitted by April 1, 1977. Selection and appointment of scholars will be completed by May 2, 1977.

Application blanks and complete information may be obtained from Dr. Paul D. Williams, Jr., Assistant Director of the Summer Session, 116 Allen Building, Duke University, Durham, N. C. 27706.

**Financial Aid.** A limited amount of financial aid is available to students in summer study. Summer financial aid, determined according to demonstrated need, consists of institutional grant funds and low interest loans from the Federally Insured Student Loan program and the National Direct Student Loan program. To qualify for summer school aid, a student must be enrolled, or accepted for enrollment, at Duke during the academic year immediately preceding or immediately following the summer for which aid is requested. (Students enrolled only for the summer may be eligible to borrow from an outside lender under the Federally Insured/Guaranteed Loan program in their home state or from the school at which they are regularly enrolled. They should contact their college Financial Aid Office or State Department of Higher Education for information and applications.) Applications for aid should be submitted to the Financial Aid Office no later than the first week of each term. The type and amount of aid awarded will be determined by the Financial Aid Office based upon the student's financial need and the availability of funds. The granting or withholding of aid is a matter entirely within the discretion of the Financial Aid Office.

**Loans.** Loans are available through one of two federal loan programs. Eligibility for these loans is based on the federal requirement that financial need be demonstrated via the Parents' Confidential Statement or any other needs analysis system accepted by the federal government and approved for use by Duke University.

**Employment.** A limited number of job opportunities are available through the College Work-Study program. The Financial Aid Office does not include employment as a part of need-based summer aid packages. When, however, in the judgment of the student and the aid officer, the student's academic program allows sufficient time for employment, the student may be allowed to accept employment in the place of a loan.

Inquiries concerning need-based Financial Aid availability and application procedures should be directed to the Office of Undergraduate Financial Aid, Duke University, Durham, North Carolina 27706 or to the Financial Aid Officer of the appropriate graduate division.

**Remissions of Tuition.** Children of Methodist ministers who are members of the North Carolina and Western North Carolina Conferences of the United Methodist Church are entitled to a partial remission of the tuition charge. This consideration is given only to the children of resident members of the two North Carolina conferences who are giving their full time to religious work. Only those students enrolled in a regular undergraduate program leading to a baccalaureate degree from the University are entitled to this benefit. Students in this group are entitled to a maximum of eight semesters of eligibility at the undergraduate level. Application for this benefit should be made to the Associate Director of Undergraduate Financial Aid, Duke University, Durham, N. C. 27706.

**Tuition Grants.** Tuition grants are available to children of faculty and qualified staff members of Duke University. Information regarding the tuition grant program may be obtained by writing to the Associate Director of Undergraduate Financial Aid, Duke University.

# Registration and Regulations





## Definition of Terms

**Registration.** Students have completed registration for the summer session when:

1. Their course programs have been written and approved by the dean of the school or college in which they are enrolled or by the Director of the Summer Session in the case of the special or unclassified student.
2. Summer session forms have been completed properly by the student in the Summer Session Office, 116 Allen Building.
3. University fees for the summer session have been paid; a place in a course cannot be assured until this has been done. Tuition bills are not sent to students' homes.

**Pre-Enrollment.** The term pre-enrollment refers only to the writing of the course program and its approval by the proper authority or by the Director of the Summer Session in the case of the special or unclassified student. Pre-enrollment alone does not constitute registration.

## General Registration

In the 1977 summer session, classes in Term I will begin on Tuesday, May 10; in Term II on Monday, June 13; and in Term III on Monday, July 18. A student attending Term I, Term II or Term III of the 1977 summer session must complete registration in the Summer Session Office, 116 Allen Building, on or before the Friday preceding the first class day of the given term (Term I, Friday, May 6; Term II, Friday, June 10; Term III, Friday, July 15).

A student in classes beginning on dates other than the beginning date of each of the three terms must complete registration in the Summer Session Office before the date on which those classes begin.

## Late Registration

Any student who fails to register before the dates specified in the preceding paragraphs will be charged a fee of \$25 for late registration. All late registrations and course changes must be completed by the end of the third



class day of each term (May 12, Term I; June 15, Term II; and July 20, Term III). All course changes must be approved by the dean of the school or college in which the student is enrolled, or, in the case of the special or unclassified student, by the Director of the Summer Session.

Since summer session courses present a program of study in more concentrated and rapid form than in the regular semesters, students are advised to register on time and to be present at all class sessions.

## Advanced Registration

**Students in Residence During the Spring Semester, 1977.** Graduate and undergraduate students in residence at Duke University during the spring semester, 1977, who plan to enroll for courses or research in one or more terms of the 1977 summer session will write course programs and have them approved in their respective schools or college during the week of preregistration, March 28-April 1, 1977.

Graduate and undergraduate students in residence, whose course programs have been written and approved by their respective schools or college on the date indicated above, may complete their registration in the Summer Session Office, 116 Allen Building, by paying their tuition from May 2 to May 6, 1977.

A Duke student, graduate or undergraduate, who desires to attend the summer session but did not preregister from March 28 to April 1, 1977, should complete registration by the Friday preceding the beginning of the desired term.

**Students Not in Residence at Duke During the Spring Semester, 1977.** Students not in residence at Duke University during the spring semester, 1977—new undergraduate students seeking to enter as degree candidates, graduate students who are not candidates for an advanced degree at Duke University, graduate and undergraduate students of other colleges and universities desiring to earn credits for transfer, public school teachers, and college teachers (not advance degree candidates)—may register by mail. Advance registration by mail includes:

1. Completion in full of the application at the end of this *Bulletin*.
2. Admission to the summer session by the Director of the Summer Session and, in case of a student seeking to enter Duke University as a degree candidate, admission by the admissions director to the school or college of Duke University concerned.
3. Completion in full and return of forms required by the Summer Session Office at least one week prior to the beginning of the term involved.
4. Payment of tuition by at least one week prior to the beginning of classes.

Students who have not completed registration by mail for courses in Terms I, II, and III should complete their registration in the Summer Session Office, 116 Allen Building, by the Friday previous to the first class day of Term I, II, and III.

**Degree-Candidate Graduate Students Not in Residence During the Spring Semester, 1977.** A graduate student not in residence during the spring semester, 1977, who is a candidate for an advanced degree in the Graduate School of Duke University, may complete registration by mail if the director of graduate studies and the Graduate School approve the registration. The student will follow the same four steps given above. Any graduate student unable to complete registration by mail must be present for registration in the Summer Session Office on or before May 6 for Term I, June 10 for Term II, and July 15 for Term III.





**Registration of Graduate Students.** Graduate students in residence during the spring semester will preregister for one or more terms of the summer session on March 28 through April 1. Newly admitted graduate students who have not completed their registration by mail should present themselves for registration at the official registration periods. All graduate students are required to register both with the Summer Session Office and with the Graduate School Office.

Graduate students resident in the spring semester who intend to remain in residence during one or more of the three summer session terms without registering for course work or at least 1 unit of research must register for 1 unit to cover the cost of medical care and the use of the University facilities. These units of registration, along with the Student Health Fee, will entitle students to use the Student Health Service and University facilities during the three terms of the summer session. The master's candidate who has completed all requirements except submission of the thesis and who so registers is not charged any separate fee for submitting the thesis, but is required to register for 1 unit of research.

**Graduates Not in Residence at Duke During the Spring Semester, 1977.** Students who are seeking admission to the Graduate School and those who have been admitted to the Graduate School must also file Graduate School application forms which may be secured by writing to the Dean of the Graduate School, Duke University, Durham, North Carolina 27706.

Students with graduate standing and currently employed as teachers who wish only to earn credits toward renewal or the advancement of their certificate may enroll in the summer session as unclassified graduate students without becoming candidates for a degree at Duke University. Credits earned by unclassified graduate students in graduate courses at Duke may later be counted toward an advanced degree at Duke if the conditions stated on page 4 are met. All students in the unclassified category should apply to the Director of the Summer Session for admission. The application form at the end of this *Bulletin* may be used.

## Academic Regulations

**Types of Course Enrollment.** Summer session courses may be taken for credit or may be audited. A student's program may be exclusively in one of these categories, or a combination of the two. Students taking a full or partial program for credit may enroll as auditors in any number of additional courses.

The summer session term *credit* does not mean degree credit at Duke University unless the student has been admitted as a degree candidate by one of the colleges or schools of the University. A student taking a course for credit is expected to do all the work required and to take the final examination, and will receive a grade. G. I. Bill benefits are available only to those veterans who enroll for credit.

An auditor is entitled to listen to lectures and class discussions, but may not participate in discussions or take examinations. A student carrying a full program for credit may be given permission to audit as many courses as desired without additional fees. Students carrying less than a full program for credit may secure permission to audit but are required to pay the auditing fee, which is half the regular fee.





**Credits.** The summer session courses are of the same quality and credit values as courses in the regular semester. Credit earned in the summer session is in terms of courses or units. The majority of summer session courses carry one course to 3 graduate units of credit and require one term in residence.

Students desiring either graduate or undergraduate credits transferred from Duke University to their universities or colleges as degree credit must request from the Director of the Summer Session, Duke University, a Course Approval Form to be completed by their own dean or registrar. This form must then be returned to the Director of the Summer Session, Duke University.

Under certain circumstances a maximum credit of 6 units in a master's degree program may be allowed for graduate courses completed elsewhere. Approval for the transfer of credits will not be given until the student has spent one semester or two terms in residence. The acceptance of credit up to this amount will not reduce the minimum period of full-time registered residence at Duke University. In no case will credit be allowed for extension or correspondence courses.

With the approval of both the student's major department and the Dean of the Graduate School, a student who is granted such transfer of credit may be permitted to register for as much as 12 units of thesis research instead of the usual 6 units. The student may be permitted to fill out the schedule with as much as 6 units of further undergraduate training or 6 units of required language courses on the undergraduate level.

For regulations concerning the application of graduate credit earned elsewhere to a graduate program here, consult the *Bulletin of the Graduate School*. See page 7 for information concerning the Cooperative Program with the University of North Carolina (also including North Carolina State University and North Carolina Central University).

Professional credits toward teacher's certificates are granted by the various state boards of education, each in accordance with its own carefully planned rules. Teachers in service, before enrolling for certification credit, should consult the rules laid down by their state board of education. If necessary, they should send to their state board of education a list of the courses in which they plan to enroll and inquire whether these will be acceptable for certification credit.

**Maximum Course Program.** The maximum program for one term of the summer session is two courses.

**Dropping of Courses.** During the first three days of classes in any term, a student may add or drop a course with the permission of an academic dean. (The permission of the Director of the Summer Session is required for students from other universities or colleges.) Courses dropped after the second week are assigned a *WP* or *WF* grade. Courses dropped without permission are assigned a grade of *F*.

**Grading.** Only a student taking a course for credit will receive a grade. The grade given represents the quality of the work done in the course.

*Passed.* The following are passing grades for undergraduates and graduates:

**Undergraduate Grades**

*A*—exceptional  
*B*—superior  
*C*—satisfactory  
*D*—low pass

**Graduate Grades**

*E*—exceptional  
*G*—good  
*S*—satisfactory

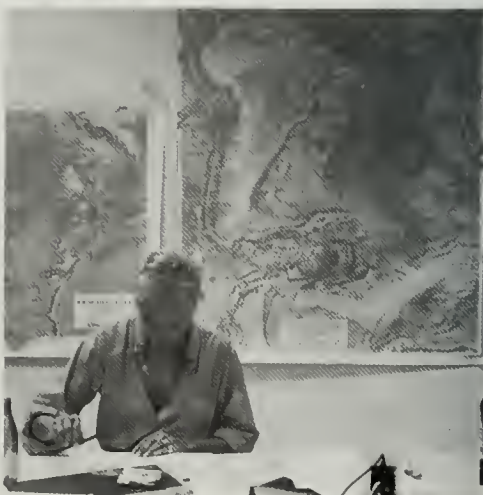
*Failed.* A grade of *F* indicates that the student has failed the course. In order to receive credit for the course the student must repeat work in class.

*Pass/Fail Option.* With the consent of the instructor and faculty adviser, a student who has declared a major may choose to be graded on a pass/fail basis in one elective, non-major course each summer. In addition, with the consent of the instructor, adviser, and director of undergraduate studies, a student may take for pass/fail credit courses in independent study or internship in any department including that of the major. Certain internships and small group experiences will be offered only on a pass/fail basis. Students may change to the pass/fail option only during the first three class days of each term.

For the effect of the election of the pass/fail option in determining honors, consult the *Bulletin of Undergraduate Instruction*.

*Incomplete.* A grade of *I* may be reported by instructors if for any reason they are unable to report the final grade at the normal time. Incomplete courses must be completed before the close of the succeeding semester; otherwise the *I* is recorded as *F*, and the course must be repeated in class if the student is to receive credit for it.

*Absent from Final Examination.* The grade of *X* indicates that the student was absent from the regularly scheduled examination. A student absent from examination, if the absence has been excused by the dean of the college or school in which the student is enrolled or, in the case of the special or unclassified student, by the Director of the Summer Session, may receive an examination upon the payment of \$5.00 to the Bursar of the University. The instructor concerned arranges for the examination in cases where absences are excused. A student





with an *X* grade who has not obtained a passing grade before the end of the semester following that in which the *X* was incurred is regarded as having failed in the course concerned and must repeat the work in class in order to receive credit. If the absence from an examination is not excused by the dean of the college or school in which the student is enrolled or, in the case of the special or unclassified student, by the Director of the Summer Session, the grade for the course concerned is recorded as *F*.

**Examinations.** Final examinations in courses are held on the last two days of each term. Final examinations for short courses will be held on the last day of the course. The examination dates for the First Term are June 10, 11; Second Term, July 14, 15; and Third Term, August 18, 19.

Courses in science for the first term have been scheduled so that their final examination will come on June 11. The science courses which begin on June 13 and run for four weeks will have their final examinations on July 8. The University has no provision for giving examinations *in absentia*. Students absent from examinations for valid reasons are permitted a liberal extension of time to return to the University for the completion of credit.

**Continuation Requirements.** A student must achieve a satisfactory record of performance during the summer session in order to maintain enrollment at Duke. Students regularly enrolled in Trinity College of Arts and Sciences who fail more than one course in a summer term or in a summer session will be excluded from the College. Where continuation from the summer session into the fall semester is in question, incomplete work in any course is considered failure to achieve a satisfactory performance in that course. Such courses must be completed in time for final grades to be submitted to the Registrar no later than the day preceding the first day of classes for the fall semester. No student who has incomplete course work from both the spring semester and the summer session may continue into the fall semester.

A student from another university or college may be dismissed by the Director of the Summer Session for failure to exhibit satisfactory performance.

**Withdrawal from the Summer Session.** If students wish to withdraw from the summer session, they must notify both the dean of the school or college in which they are registered and the Director of the Summer Session.

## Motor Vehicle Regulation

Students enrolled in the summer session must register their motor vehicles with the Traffic Control Office, 2010 Campus Drive, West Campus.

To register a vehicle, the student must present the following documents: (1) state vehicle registration certificate, (2) valid driver's license. A small parking fee will be charged.

Parking, traffic, and safety regulations will be given each student who registers a vehicle. Students are expected to abide by these regulations.

# Courses of Instruction





## Course Enrollment

**Eligibility.** Courses numbered 1-49 are primarily for freshmen, or freshmen and sophomores. Courses numbered 50-99 are ordinarily for sophomores, or sophomores and juniors. Courses numbered 100-199 are designed for juniors and seniors. Courses numbered 200-299 are planned for seniors and graduates. Courses numbered 300 up admit graduate students only. Courses numbered from 200 up are limited in enrollment to twenty-five students.

**Minimum Enrollment Required.** All courses are offered subject to minimum enrollments. The University reserves the right to withdraw undergraduate courses in which fewer than twelve students enroll, senior-graduate courses numbered 200-299 in which fewer than ten students enroll, and graduate courses and seminars numbered 300 or above in which fewer than six students enroll. In withdrawing a course, the University attempts to avoid undue hardships on students. Sometimes, therefore, courses are offered in spite of small enrollments. Courses not listed will be given when a demand develops and an instructor is available.

## Departmental Officials and Regulations

Departments offering summer session programs are listed alphabetically. Under each department is given the name of the chairman, the director of graduate studies, and the director of undergraduate studies. Where departments have set up special regulations for admission to candidacy for the master's degree, these are included.

## Summer Session Schedule of Classes

Summer session classes will meet Monday through Friday each week. Saturdays during each term are available for conferences or special class work.

Class Periods are as follows:

First Period: 8:00 a.m. to 9:20 a.m.

Second Period: 9:40 a.m. to 11:00 a.m.

Third Period: 11:20 a.m. to 12:40 p.m.

Fourth Period: 1:20 p.m. to 2:40 p.m.

The meeting place for a course is indicated immediately after the class period for the course. Building designations are as follows:

**East Campus**

A—West Duke

B—Carr

C—Science

E—Biddle Music Building

F—Bivins

**West Campus**

3—Gray

4—Perkins Library

5—Foreign Languages

9—Psychology-Sociology

10—Social Sciences

47—Engineering

49—Physics

53—Allen

58—Biological Sciences

65—Gross Chemistry

CG—Card Gym

Consult the map of Duke University located in the back of this *Bulletin* for building locations listed by name, not number.

## Anatomy

Professor Robertson, *Chairman* (465 Sands Building); Associate Professor Hylander, *Director of Graduate Studies* (270 Sands Building)

### First Term

**151. Anatomy of the Lower Extremities as it Relates to Locomotion.** Dissection of the human adult lower extremity. Demonstration and discussion of gait, biomechanics, and kinesiology. One course. *Bassett*. 9:40-11:00. Bell 013

**312. Research.** Individual investigations in various fields of anatomy. (Consult *Graduate School Bulletin* for description.) Credits to be arranged. Consent of staff required. *Staff*

**340. Tutorial in Advanced Anatomy.** (Consult *Graduate School Bulletin* for description.) *Staff*

**354. Research Techniques in Anatomy.** (Consult *Graduate School Bulletin* for description.) *Staff*

### Second Term

**208. Anatomy of the Trunk.** Designed for Ph.D. degree candidates in anatomy as well as practitioners and specialists in surgery and internal medicine. Emphasis upon the anatomy of the thoracic, abdominal, and pelvic organs. Prerequisites: core course in anatomy and consent of instructor. Number of students arranged by staff. 2 units. *Duke*

**312. Research.** Individual investigations in the various fields of anatomy. (Consult *Graduate School Bulletin* for description.) Credits to be arranged. Consent of staff required. *Staff*



### Third Term

**312. Research.** Individual investigations in the various fields of anatomy. (Consult *Graduate School Bulletin* for description.) Credits to be arranged. Consent of staff required. *Staff*

## Anthropology

Professor Friedl, *Chairman and Director of Graduate Studies* (03 North Building); Associate Professor Apte, *Director of Undergraduate Studies* (105 North Building)

### First Term

**93. Human Origins.** Origins and distribution of mankind; primate evolution; a survey of human paleontology and human biology, prehistory, and language; and the origins of human social organization and culture. One course. *Beecher*. 1:20-2:40. 109 North Building

**94. Elements of Cultural Anthropology.** The dynamics of culture and society; form and function of social institutions. Emphasis is upon primitive societies. Primarily meant for students not majoring in the social sciences. One course. *Conti*. 8:00-9:20. 109 North Building

**107. Introduction to Linguistics.** Origin and nature of language; methods of descriptive linguistics with reference to historical and comparative linguistics. Prerequisite: sophomore standing. One course. *Hamilton*. 9:40-11:00. 109 North Building

### Second Term

**93. Human Origins.** (For course description see listing under first term.) One course. *Beecher*. 1:20-2:40. 109 North Building

**94. Elements of Cultural Anthropology.** (For course description, see listing under first term.) One course. *Hamilton*. 9:40-11:00. 109 North Building

### Third Term

**119. Language, Culture, and Society.** Analysis of language behavior within and across societies relating variations in linguistic usage to sociocultural factors: ethnosemantics, social dialects, and ethnography of speech. Prerequisite: Anthropology 94 or 99. One course. *Chordas*. 8:00-9:20. 109 North Building

**135. Anthropological Research in American Culture.** Substructures in American society studied by ethnographic field methods. Prerequisite: Anthropology 94 or 99. One course. *Conti*. 9:40-11:00. 109 North Building

## Art

Professor Markman, *Acting Chairman and Director Undergraduate Studies*. (204 Art Building, East Campus)

### First Term

**53. Drawing.** Directed approaches to practice in life drawing and in the expression of graphic concepts. Prerequisite: consent of instructor. (Enrollment limited to eighteen.) One course. *S. Pratt*. 10:00-12:40. A.106

**54. Two-Dimensional Design.** Experiments in form and color, with work from observation. Introduction to color theory in painting and two-dimensional media. Prerequisite: Art 53 or consent of instructor. One course. *S. Pratt*. 1:20-4:00. A.106

**153. Painting.** Studio practice in painting with individual and group criticism and discussion of important historic or contemporary ideas. Prerequisite: Art 54 or equivalent, and consent of instructor. One course. *V. Pratt.* 1:20-4:00. H.203

**155. Advanced Drawing and Color.** Work from life or in formal modes, with emphasis on personal development through individual and group criticism and discussion. Prerequisite: Art 53 and 54, or consent of instructor. One course. *V. Pratt.* 10:00-12:40. H.201

**173. Advanced Painting.** Prerequisites: Art 153 and 154 and consent of instructor. One course. *V. Pratt.* 1:20-4:00. H.203

**Studio Fees.** A fee of \$40 will be charged to cover the cost of models and supplies.

## Biochemistry

Professor Hill, *Chairman* (255 Nanaline H. Duke); Professor Rajagopalan, *Director of Graduate Studies* (235B Nanaline H. Duke)

### Second Term (Marine Laboratory, Beaufort)

**276. Comparative and Evolutionary Biochemistry.** Lectures and discussion of the origin of life, evolution of the genetic code, mutation and protein polymorphism, natural selection and protein structure, and comparison of homologous proteins and nucleic acids. Laboratory work involves the purification and characterization of homologous proteins from fish and invertebrates. Techniques used include salt fractionation, electrophoresis, ion-exchange and molecular exclusion chromatography, fingerprinting, molecular weight determination, amino acid composition, and other related approaches. Prerequisite: consent of instructor. One and one-half courses. (6 graduate units.) *Sullivan*

## Biology\*

### Third Term

**14. Principles of Biology.** A one-semester introduction to the discipline open to freshmen with at least one year of biological science in high school and to all upperclassmen. Lectures and laboratories. One course. *Staff.* 9:30-11:10, Monday through Friday. 58.130. 2:00-5:00, Monday through Wednesday. 58.115

## Botany

Professor Wilbur, *Chairman* (149 Biological Sciences); Associate Professor Searles, *Director of Graduate Studies* (257 Biological Sciences); Professor White, *Director of Undergraduate Studies* (371 Biological Sciences)

Students admitted to candidacy for an advanced degree in botany should have completed a minimum of 12 semester hours of courses in botany (or biology) beyond an elementary course, and related work in biological sciences. Students who have not yet had the minimum hours, however, may enter higher courses by permission of the instructor, if the instructor is convinced that they can carry the work for undergraduate credit, and may count such work toward hours necessary for candidacy.

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\*See other courses listed under Botany and Zoology.

### First Term (Durham campus)

**191. Independent Study.** Directed reading and research. Open only to highly qualified students in the junior and senior years by permission of the department. Credits to be arranged. *Staff*

**145L/245L. Plant Diversity.** Major groups of the living plants, their evolutionary origins and phylogenetic relationships. Prerequisite: introductory biology or permission of instructor. One course. (4 graduate units.) *White*. 8:00-12:00. 58.154

**359/N. Research.** Credits to be arranged. *Staff*

### First Term (Marine Laboratory, Beaufort)

**191T. Independent Study.** For senior and junior majors with consent of the appropriate director of undergraduate studies and supervising instructor. Credits to be arranged. *Staff*

### Second Term (Durham campus)

**192. Independent Study.** Directed reading and research. Open only to highly qualified students in the junior and senior years by permission of the department. Credits to be arranged. *Staff*

**359. Research.** Credits to be arranged. *Staff*

### Second Term (Marine Laboratory, Beaufort)

**192T. Independent Study.** For senior and junior majors with permission of the appropriate director of undergraduate studies and supervising instructor. Credits to be arranged. *Staff*

**211. Marine Phycology.** An introduction to marine algae—their identification, taxonomy, morphology, physiology, and ecology. Field trips are complemented by laboratory study, culturing, and preparation of herbarium material. One and one-half courses. (6 graduate units.) *Searles*

### Third Term (Durham campus)

**191. Independent Study.** Directed reading and research. Open only to highly qualified students in the junior and senior years by permission of the department. Credits to be arranged. *Staff*

**359. Research.** Credits to be arranged. *Staff*

### Third Term (Marine Laboratory, Beaufort)

**191T. Independent Study.** For senior and junior majors with permission of the appropriate director of undergraduate studies and the supervising instructor. Credits to be arranged. *Staff*

## Chemistry

Professor Krigbaum, *Chairman* (101 Paul M. Gross Chemical Laboratory); Professor Jeffs, *Director of Graduate Studies* (330 Paul M. Gross Chemical Laboratory); Professor Poirier, *Director of Undergraduate Studies* (333 Paul M. Gross Chemical Laboratory)

All classes in chemistry, Term I, will begin on May 16 and continue through June 11. Classes in Term II will begin on June 13 and continue through July 8. Classes in Term III will begin on July 18 and continue through August 19.

## First Term

**11. Principles of Chemistry.** The introductory course for students who intend to take any additional chemistry courses other than Chemistry 103. Emphasizes stoichiometry and molecular structure. Laboratory work includes both qualitative and quantitative analysis. Prerequisites: one year of high school chemistry or Chemistry 10, and qualification for Mathematics 31. One laboratory course. *Wilder*. Laboratory daily, 9:30-12:30; recitation and lecture daily, 1:30-3:30. Laboratory, 65.211; lecture and recitation, 65.103

**151. Organic Chemistry.** The structures and reactions of the compounds of carbon. Laboratory experiments illustrate the techniques of separation and structure determination. Prerequisite: Chemistry 12 or its equivalent. One laboratory course. *Peterson*. Lecture daily, 9:30-11:30; laboratory Monday through Thursday, 12:30-4:30. Laboratory, 65.224; lecture, 65.107

**161. Physical Chemistry.** Fundamentals of theoretical chemistry illustrated by selected laboratory experiments. Prerequisites: Chemistry 152, Physics, 51, 52, and Mathematics 32. One laboratory course. *Smith*. Laboratory daily, 9:30-12:30; recitation and lecture daily, 1:30-3:30. Laboratory, 65.229; lecture and recitation, 65.110

**375. Research.** The aim of this course is to give instruction in methods used in the investigation of original problems. Individual work and conferences. Graduate credit to be arranged. *Staff*

## Second Term

**12. Principles of Chemistry.** Continuation of Chemistry 11. Emphasizes thermodynamics, chemical kinetics, synthesis, and analysis. Prerequisite: Chemistry 11 or its equivalent. One laboratory course. *Palmer*. Laboratory daily, 9:30-12:30; recitation and lecture daily, 1:30-3:30; Lecture and recitation, 65.211; laboratory, 65.103

**152. Organic Chemistry.** Continuation of Chemistry 151. Laboratory experiments illustrate organic reactions and preparations. Prerequisite: Chemistry 151. One laboratory course. *Staff*. Lecture daily, 9:30-11:00; laboratory, Monday through Thursday, 12:30-4:30. Lecture 65.107; laboratory 65.224

**240. Chemical Oceanography.** Distribution, alteration, and transport of chemical species in the marine environment. *R/V Eastward* cruise to gather samples for evaluating chemical processes in the ocean. Prerequisite: consent of instructor; knowledge of physical chemistry is recommended. (Given at Beaufort; also listed as Marine Sciences 240.) Includes lectures, laboratory work, and field trips. One and one-half laboratory courses. (6 graduate units.) *Staff*

## Third Term (Marine Laboratory, Beaufort)

**230. Environmental Oceanography.** Examination of chemical, biological, and geological aspects of pollution in the marine environment. The interaction of man with natural marine processes on shore lines and shelves. Application of marine science to compatible utilization of marine resources. Prerequisite: consent of instructor. A knowledge of physical chemistry is desirable. One and one-half courses. (6 graduate units.) *Staff*

## Classical Studies

Professor Oates, *Chairman* (325 Carr Building, East Campus); Assistant Professor Burian, *Director of Undergraduate Studies* (320 Carr Building, East Campus)



## CLASSICAL STUDIES

### First Term

**54. Roman History.** The Roman Republic and Empire to the Council of Nicaea. (Also listed as History 54.) One course. *Oates*. 11:20-12:40. 5.219

**133. Early Greece and the Near East.** Political, social, and intellectual developments from the world of Homer to the Persian Wars. (Also listed as History 96.) One course. *Oates*. 9:40-11:00. 5.219

## GREEK

### First Term

**181S. Greek Seminar.** An intensive introduction to the language and literature. Open only to students who have achieved proficiency in another language. Two courses. *Staff*. 8:00-9:20. B.206

**191. Independent Study.** Directed reading and research. Open to highly qualified juniors and seniors. One course. *Staff*

## LATIN

### First Term

**181S. Latin Seminar.** An intensive introduction to the language and literature. Open only to students who have achieved proficiency in another language. Two courses. *Staff*. 8:00-9:20. B.206

**191. Independent Study.** Directed reading and research. Open to highly qualified juniors and seniors. *Staff*

## GREEK

### Second Term

**182S. Greek Seminar.** Continuation of Greek 181S. Two courses. *Staff*. 8:00-9:20. B.206

**192. Independent Study.** Directed reading and research. Open to highly qualified juniors and seniors. One course. *Staff*

## LATIN

### Second Term

**182S. Latin Seminar.** Continuation of Latin 181S. Two courses. *Staff*. 8:00-9:20. B.206

**192. Independent Study.** Directed reading and research. Open to highly qualified juniors and seniors. One course. *Staff*

## Comparative Literature

Professor Anderson, *Chairman of the Committee on Comparative Literature* (401 Perkins Library)

### Second Term

**151. Theory and Form of Tragedy.** (Also listed as French 151.) Graduate credit may be arranged. One course. *Fowlie*. 8:00-9:00. 5.014

## Computer Science

Professor Loveland, *Chairman* (203 North Building); Professor Gallie, *Director of Undergraduate Studies* (205 North Building)

### First Term

**51. Introduction to Digital Computation.** Flow charts; an assembly language; program structures, subroutines, data structures, arrays, polynomials, an algorithmic language; numerical linear algebra; matrix inversion, linear programming, and least-squares techniques. One course. *Patrick*. 8:00-9:20. 56.227

**221. Numerical Analysis I.** Error analysis and interval arithmetic, interpolation and polynomial approximation methods, numerical differentiation and integration, solution of simultaneous linear equations and matrix inversion, real and complex roots of nonlinear equations. Prerequisite: knowledge of an algorithmic programming language and intermediate calculus. (Also listed as Mathematics 221.) One course. (3 graduate units.) *Patrick*. 9:40-11:00. 56.227

### Second Term

**251. Computer Science for Teachers.** An introduction to digital computation which concentrates on computer instruction in the high school and on the employment of computer processes in instruction and school administration. Prerequisite: a year of basic mathematical analysis at college level. One course. (3 graduate units.) *Staff*. 8:00-9:20. 56.227

## Divinity School

Professor Langford, *Dean* (107B New Divinity School); Professor Lacy, *Associate Dean for Curricular Affairs* (101C New Divinity School)

### First Term

**N. T. 103. Hellenistic Greek.** Designed for beginners to enable them to read the Greek New Testament. (Two semesters: no credit will be given for 103 without completion of 104.) 3 semester hours. *Efird*

**399.** By special arrangement with an instructor, a student may arrange for independent study in a given area of specialized research. Prerequisite: consent of instructor and the associate dean.

### Second Term

**N. T. 104. Hellenistic Greek.** (Two semesters: only for students who have completed N.T. 103 or at least one full year of college Greek.) 3 semester hours. *Efird*

## Drama

Associate Professor Clum, *Director of the Duke University Drama Program* (317 Carr Building, East Campus)

### First Term\*

**101. Acting.** Basic acting skills; diction, movement, improvisation, interpretation. One course. *Clum*. 1:20-2:40. D.209

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\*See also English 124: Shakespeare. *DeNeef*.

**104. Stagecraft.** An introduction to the technical aspects of play production: scenery, lighting, properties. Laboratory work coordinated with productions of Summer Theater at Duke. One course to be continued into Term II. Both terms must be taken for full credit. *Parker*. 3:30-5:00. Branson Theater

**181S. Conference on Special Topics: Naturalism and its Legacy.** From the naturalism of Zola to such modern playwrights as O'Neill, Miller, and Williams. Plays offered by Summer Theater at Duke will be included. (Also listed as English 181S.) One course. *Reardon*

**191, 193 Independent Study in Acting, Directing, or Design.** Supervised projects. See Professor Clum for details. One course. *Staff*

## Second Term†

**104. Stagecraft.** Continued from Term I. *Parker*

**181S. Conference on Special Topics: Advanced Scene Study.** Intensive work in role preparation. Prerequisite: consent of instructor. *Clum*. 1:20-2:40. D.209

**191, 193. Independent Study in Acting, Directing, or Design.** Supervised projects. See Professor Clum for details. One course. *Staff*

## Economics

Professor Kelley, *Chairman* (215-A Social Sciences); Associate Professor Weintraub, *Director of Graduate Studies* (315 Social Sciences); Professor Davies, *Director of Undergraduate Studies* (302 Social Sciences)

### First Term

**51. National Income and Public Policy.** Basic economic analysis emphasizing current public policy issues. How the level and rate of growth aggregate national income and output are determined. What causes unemployment, inflation, and international payments problems. How monetary policy (money supply and interest rates) and fiscal policy (government expenditures and taxes) affect these problems. One course. *Bolnick*. 9:40-11:00. 10.231

**108. Economics of War.** Conflict theory, causes and economic consequences of war, military manpower, military-industrial complex, disarmament and the economy. Prerequisite: Economics 52. One course. *Weintraub*. 11:20-12:40. 10.232

**153. Monetary Economics.** The evolution and operations of commercial and central banking and non-banking financial institutions in the United States, determination of monetary aggregates and interest rates, the financial impacts of Treasury operations, and linkages from Federal Reserve actions to price level, employment, economic growth, and balance of payments objectives. One course. *Yohe*. 9:40-11:00. 10.136

**154. Aggregative Economics.** Concepts and measurement of national income and expenditures, employment, interest rates, and price levels; the theoretical determination of these aggregates; applications of macroeconomic theory to business cycles and economic growth. One course. *Bronfenbrenner*. 8:00-9:20. 10.231

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†See also English 184S. Conference on Special Topics: Classic American Literature in Drama and Film. *Jones*.

**314. Seminar in Economic Theory.** Prerequisite: Economics 301 or its equivalent. 3 units. *Weintraub*. 8:00-9:20. 10.214

## Second Term

**52. Competition, Monopoly, and Welfare.** A continuation of Economics 51. How the composition of the economy's output and the distribution of its income (who is rich and who is poor) are determined in a market economy by supply and demand. How and why markets work or fail to work and the implications of social policies. Role of government in a market economy: contemporary problems of the environment, topics such as environmental economics, monopoly, unionism, international trade. Comparison of a market economy with other systems of economic organization. Economic problems of developing countries. (Open only to freshmen.) One course. *Wyse*. 11:20-12:40. 10.227

**106. The Economics of Poverty.** Poverty in the United States: its definition, measurement, history, racial dimensions, and the present and proposed policies for its amelioration. Prerequisite: Economics 52. One course. *Goalstone*. 9:40-11:00. 10.227

**138. Economic Statistics.** (Also listed as MS 110.) Survey of principal concepts and methods; application to economics. (Not open to students who have had Mathematics 53 or 183, Management Sciences 110, Psychology 117.) One course. *Wyse*. 8:00-9:20. 10.227

**149. Microeconomic Theory.** Cost and supply consideration in price theory; the demand for factors of production. The allocation of resources is examined in the context of competitive and monopolistic market structures. (Not open to students who have had either Economics 161 or Public Policy Studies 110.) *Ross*. 11:20-12:40. 10.220

## Education

Professor Flowers, *Chairman* (213-I West Duke Building, East Campus, and 01 Allen Building, West Campus); Professor Petty, *Director of Graduate Studies* (06-B West Duke Building, East Campus); Associate Professor Colver, *Director of Undergraduate Studies* (205 West Duke Building, East Campus)

Duke University is accredited by the National Council of Accreditation of Teacher Education for the preparation of elementary and secondary school teachers and school service personnel, with the doctoral degree as the highest degree approved.

It is the intention of the department to make available to degree candidates all courses ordinarily required for certification as graduate teachers, counselors, principals, and superintendents. These courses will normally be offered at least once every three years.

## First Term

**100. Social and Philosophical Foundations of Education.** Basic features and assumptions, viewpoints, and issues of education in contemporary America. One course. *Di Bona*. 9:40-11:00. A.202

**202. Comparative and International Education: Industrialized Nations.** Structure and functioning of educational institutions in selected developed societies. Relevant social science theory and methods. One course. (3 graduate units.) *Di Bona*. 11:20-12:40. A.202



## Second Term

**204. Educational Organization.** Theory and research on the processes of exchange between educational organizations and their external environments; influence on organizational structure, goals, and practices. Examining schools, colleges, and universities through a comparative approach with other forms of social organizations: hospitals, businesses, and prisons. One course. (3 graduate units.) *Martin*. 9:40-11:00. 4.027

**221. Programs in Early Childhood Education.** Objectives and philosophy underlying programs in early childhood education. One course. (3 graduate units.) *Lehane*. 8:00-9:20. A.202

**224. Teaching the Social Studies in Elementary Schools.** One course. (3 graduate units.) *Cartwright*. Tuesday and Thursday. 7:00-9:45 p.m. A.202

**225. The Teaching of History and the Social Studies.** Evaluation of the objectives, content, materials, and methods in the teaching of history and the social studies. One course. (3 graduate units.) *Cartwright*. Tuesday and Thursday. 7:00-9:45 p.m. A.202

**231. Humanities for Young Children.** Adapts selected great works in history, music, dance, drama, and art into ongoing classroom activities for children. One course. (3 graduate units.) *Lehane*. 9:40-11:00 A.202

**239. Teaching of Grammar, Composition, Mechanics, and Usage in Secondary School.** Recent developments. One course. (3 graduate units.) *Shuman*. 2:30-3:50. A.202

**243. Personality Dynamics.** Personality structure and dynamics emphasizing implications for counseling and instruction. Prerequisite: six units of psychology or educational psychology. One course. (3 graduate units.) *S. Gehman*. 11:20-12:40. A.204

**246. Teaching of Mathematics.** Aims, curriculum, and classroom procedure for teaching secondary school mathematics. One course. (3 graduate units.) *Staff*. 2:30-3:50. A.104

**249. Exceptional Children.** Survey of major categories of exceptional children: mentally retarded, emotionally disturbed, brain injured, learning disabled, physically handicapped, visual and auditory deficient, culturally deprived, and gifted. Etiology (biological and environmental factors), diagnosis, and treatment. One course. (3 graduate units.) *Davis*. 11:20-12:40. A.103

**253. Introduction to Law and Education.** Basic elements of legal research, with primary emphasis on concepts and procedures relevant to educational problems. Analysis of selected cases. One course. (3 graduate units.) *Martin*. 8:00-9:20. 4.027

**276. The Teaching of High School Science.** Discussion, lectures, and collateral reading related to such topics as aims, tests, curriculum, classroom and laboratory procedure, field trips, and course and lesson planning for secondary-school science. One course. (3 graduate units.) *Staff*. 2:30-3:50. A.103

**303. Diagnostic and Educational Programs in Learning Disabilities.** Diagnostic, intervention, and remediation strategies and program development for the child with learning disabilities; review of major works in this field. Prerequisite: consent of instructor. 3 units. Enrollment fifteen. *Davis*. 9:40-11:00. A.212

**315. Seminar in Secondary School Teaching.** (Two sections: 315A, 315B).

Advanced-level consideration of principles, practices, and problems in secondary school instruction. Designed particularly to accompany an internship. For students without previous internship credit this course must be accompanied by Education 216. 3 units. *Carbone*. 9:00-1:45. Rogers-Herr Junior High School

**321. Educational Management.** Theory and practice of management as applied to education. For anyone who has or is preparing to have major management responsibilities in the field of education. 3 units. *Pittillo*. 11:20-12:40. A.202

**323. Public School Finance.** Educational costs, sources of revenue for the support of public education, collection of revenue, basis of distribution, and accounting for funds spent. 3 units. *Pittillo*. 8:00-9:20. A.212

**326. Educational Psychology: The Problem Child.** Problem behavior and adjustment in children with emphasis on the causes and treatment of conduct and neurotic disorders of the maladjusted child. Particular attention will be paid to mental hygiene principles in the handling of problem children in school and home. 3 units. *S. Gehman*. 9:40-11:00. A.204

### Third Term

**217. The Psychological Principles of Education.** Advanced study of teaching, learning, and the learner. One course. (3 graduate units.) *Sawyer*. 9:40-11:00. A.202

**223. Teaching the Language Arts.** Comparison of current methods and materials in the teaching of handwriting, spelling, and oral and written composition. Analysis and correction of basic difficulties. One course. (3 graduate units.) *Adams*. 9:40-11:00. 53.233

**234. Secondary School Organization and Administration.** Objectives and philosophy underlying the organization and administration of the secondary school. One course. (3 graduate units.) *Flowers*. 8:00-9:20. 53.226

**236. Teaching Developmental and Remedial Reading in the Secondary School.** Principles, methods, and materials for the development of effective reading attitudes and skills in developmental and remedial programs. One course. (3 graduate units.) *Adams*. 11:20-12:40. 53.233

**256. Classroom Assessment of Student Achievement.** The techniques used by classroom teachers to evaluate student progress. Special emphasis will be directed to tests written by teachers. One course. (3 graduate units.) *Colver*. 11:20-12:40. A.202

**332. Supervision of Instruction.** The nature of supervision, underlying principles, and techniques of working with individual teachers and with groups. 3 graduate units. *Staff*. 8:00-9:20. A.202

## Engineering

Professor Vesic, *Dean of the School of Engineering* (136 Engineering Building); Assistant Professor George, *Assistant Dean* (136 Engineering Building)

### First Term

**113. Introductory Systems Theory.** Fourier series. Fourier and Laplace transforms; transfer function analysis. Impulse functions; impulse response of systems; convolution and time domain analysis. Discrete time models and computer simulation of continuous systems. Multiple input-output systems; introduction to state variable analysis. Prerequisites: Electrical Engineering 63. One course. *Kerr*. Hours to be arranged.

**197-198.\* Projects in Civil Engineering.** These courses may be taken by junior and senior engineering students who have demonstrated aptitude for independent work. Prerequisites: consent of instructor and Director of Undergraduate Studies. Each, half-course or one course. *Staff*

**155.\* Special Topics in Electrical Engineering.** Study of selected topics in electrical engineering tailored to fit the requirements of a small group. Prerequisites: consent of Director of Undergraduate Studies and instructor. Each, half-course or one course. *Staff*

**173.\* Projects in Electrical Engineering.** A course which may be undertaken only by seniors who are enrolled in the Graduation with Distinction program, or who show special aptitude for individual project work. Elective for electrical engineering majors. Prerequisite: consent of Director of Undergraduate Studies. Half-course to two courses. *Staff*

**265.\* Advanced Topics in Electrical Engineering.** Opportunity for study of advanced subjects related to programs within the Electrical Engineering Department tailored to fit the requirements of a small group. Prerequisites: consent of Director of Graduate Studies and of instructor under whom work will be done. One course. *Staff*

**399.\* Special Readings in Electrical Engineering.** Special individual readings in a specified area of study in electrical engineering. Prerequisite: consent of the Director of Graduate Studies. 1 to 3 graduate units. *Graduate Staff*

**165.\* Special Topics in Mechanical Engineering and Materials Science.**

**198.\* Projects in Mechanical Engineering and Materials Science.**

**265.\* Advanced Topics in Mechanical Engineering and Materials Science.**

**399.\* Special Readings in Mechanical Engineering and Materials Science.**

## English

Professor Budd, *Chairman* (325 Allen Building); Professor Nygard, *Director of Graduate Studies* (315 Allen Building); Associate Professor Butters, *Director of Undergraduate Studies* (322 Allen Building)

Candidates for the master's degree in English are expected to have had at least 18 units in undergraduate courses above the sophomore level. The department may also require additional courses if the work of the student in the first term indicates inadequate preparation.

### First Term

**24S. Studies in Poetry.** A study of the nature of poetry—its language, forms, and themes—with emphasis on British and American poetry of the twentieth century. One course. *Jackson*. 11:20-12:40. 53.328

**56. Representative British Writers.** Novels by Fielding (*Joseph Andrews*), and Dickens (*Great Expectations*), and selections from the poetry of Pope, Wordsworth, Keats, and Yeats. One course. *DeNeef*. 9:40-11:00. 53.326

**104S. Creative Writing.** Class discussion of students' manuscripts and individual conferences with the instructor. Open to sophomores, juniors, and

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\*This course will be offered Terms II and III also.

seniors. Each student must bring a piece of prose fiction to the first class meeting. One course. *Monsman*. 1:20-2:40. 53.318

**124. Shakespeare.** About ten plays after 1600. One course. *DeNeef*. 8:00-9:20. 53.327

**181S. Conference on Drama: Naturalism and Its Legacy.** From the Naturalism of Zola to such modern playwrights as O'Neill, Miller, and Williams. Plays offered by Summer Theater at Duke will be included. One course. *Reardon*. 1:20-2:40. 53.318

**241. English Literature of the Early Nineteenth Century.** Poets and prose writers, 1790-1810, with emphasis on Wordsworth and Coleridge. One course. *Monsman*. 9:40-11:00. 53.318

## Second Term

**24S. Studies in Metaphysical and Twentieth-Century Poetry.** Comparison readings of such seventeenth-century poets as Donne, Marvell, Crashaw, and Herbert along with leading moderns including Eliot, Yeats, and Hart Crane, so as to explore the living tradition of metaphysical wit. One course. *Smith*. 11:20-12:40. 53.328

**55. Representative British Writers.** Chaucer's Prologue to the *Canterbury Tales* and at least two tales; Shakespeare's *Henry IV*, or *King Lear*, and one other play; John Donne's poetry (selections), and Milton's *Paradise Lost* (selections) and some of the shorter poems. One course. *Williams*. 9:40-11:00. 53.326

**101S. Advanced Expository Writing.** Techniques of effective writing. One course. *Butters*. 9:40-11:00. 53.328

**184S. Classic American Literature in Drama and Film.** A study of approximately six novels and short stories from the nineteenth-century dramas and films. National Hawthorne, Edgar Allan Poe, Herman Melville, and Mark Twain will be included, along with Henry James and Stephen Crane if time permits. One course. *Jones*. 11:20-12:40. 53.326

**251. English Literature of the Twentieth Century.** Representative work of leading writers from 1900 to 1950, in fiction, drama, and poetry: Shaw, Conrad, Yeats, Wells, Bennett, Galsworthy, Ford, Synge, Forster, and Lawrence. One course. *Smith*. 9:40-11:00. 53.318

**287. Recent Critical Thought.** Questions of the nature and value of literature as reflected in recent criticism, theoretical and practical. One course. *Duffey*. 1:20-2:40. 53.327

## Third Term

**26S. Studies in Special Topics: The American Language.** The development of current English in the U.S.A. with emphasis on its origins in Black English and the speech of other minorities; attention also to uses and abuses in advertising, government, media, and relations among the sexes. One course. *Butters*. 8:00-9:20. 53.326

**58. Representative American Writers.** Selections and complete works of James, Frost or Robinson Crane or Dreiser, O'Neill, Faulkner, Hemingway, and others. Prospective majors should take courses numbered 161-162, 171-172 instead of this course. One course. *Reiss*. 11:20-12:40. 53.326

**163. Studies in a Major American Author.** Readings in the works of William Faulkner. One course. *Strandberg*. 9:40-11:00. 53.327



**208. History of the English Language.** Introductory survey of the changes in sounds, forms, and vocabulary of the English language from its beginning to the present, with emphasis on the evolution of the language as a medium of literary expression. One course. *Reiss*. 9:40-11:00. 53.326

**275. American Literature since 1915.** Selected fiction from Gertrude Stein to the present. One course. *Strandberg*. 11:20-12:40. 53.327

**280. Introduction to Folklore.** A survey of the materials of popular tradition, folksong, folktale, proverb, riddle, and other forms; the methods of folklore investigation; and the relation of these popular genres to literary tradition. One course. *Nygard*. 8:00-9:20. 53.327

## Forestry

Professor Jayne, *Dean of the School of Forestry and Environmental Studies* (213 Biological Sciences Building); Professor Anderson, *Director of Graduate Studies* (04 Biological Sciences Building)

The requirements for the degree of Master of Forestry (M.F.) are governed by the extent of the student's previous undergraduate education and by specific career objectives. Students with no prior preparation in forestry are required to begin their studies with a summer term of eight weeks.

Qualified students may engage in thesis research in certain branches of forestry during the summer session with the approval of the instructor concerned and the Dean of the School of Forestry and Environmental Studies, or of the Director of Graduate Studies in the case of work taken through the Graduate School.

### Second Term

**205F. Tree Growth and Development.** Life processes, growth, and development of trees, with emphasis on physiological processes environmental influences, on structure, composition, and function. 3 units. *Barnes*. Hours to be arranged.

**241F. Dendrology.** Nomenclature, classification, and identification of woody plants, with special reference to the tree species indigenous to southeastern United States and other important forest regions of temperate North America. Prerequisite: Biology 1-2 or equivalent. 3 units. *White*. Hours to be arranged.

**357. Research in Forestry.** Open to students whose research programs for the M.F. or D.F. degree have been approved by the Dean of the School of Forestry and Environmental Studies and the instructor responsible for directing the research.

### Third Term

**256F. Forest Measurements.** Applications of plane-surveying techniques to the measurement of land area, topography, and timber type; measurement of volume and growth of forest trees and stands; measurement of forest products. 4 units. *White*. Hours to be arranged.

## Geology

Professor Heron, *Chairman* (119 Science Building, East Campus); Professor Perkins, *Director of Graduate Studies* (118 Science Building, East Campus); Associate

Professor Furbish, *Director of Undergraduate Studies* (104 Science Building, East Campus)

#### **First Term (Durham campus)**

**3. Environmental Geology.** Earth processes and materials, as related to man. Lectures, field trips, and eight hours of mini-lab. Not open to those who have completed Geology 1 or 12. One course. *Heron*. 11:20-12:40. C.116

#### **First Term (Duke Marine Laboratory, Beaufort)**

**168. Introduction to Marine Geology.** A study of elementary geological principles relating to the modern oceans. The course will emphasize field observations of beach and estuarine processes and the study of the historical development of the ocean basins. Prerequisite: introductory geology course or consent of instructor. One and one-half courses. *Goll*

**191T. Independent Study.** For senior and junior majors with consent of the Director of Undergraduate Studies and supervising instructor. Course credit to be arranged. *Staff*

#### **Second Term (Duke Marine Laboratory, Beaufort)**

**192T. Independent Study.** For senior and junior majors with consent of the appropriate director of undergraduate studies and the instructor. Credits to be arranged. *Staff*

**205. Geological Oceanography.** Broad geological aspects of the ocean basins including origin, bottom physiography, sediment distribution, submarine sedimentary processes and shoreline processes. Field observations. Sampling procedures. Not open to students who have completed Geology 206. One and one-half courses. (6 graduate units.) *Pilkey and Glaeser*

#### **Third Term (Duke Marine Laboratory, Beaufort)**

**191T. Independent Study.** For senior and junior majors with permission of the appropriate director of undergraduate studies and the supervising instructor. Course credit to be arranged. *Staff*

**250. Introduction to Marine Geophysics.** Topics include seismic reflection and refraction, magnetics, gravity, and seismology. Prerequisite: Introductory physics or consent of instructor. One and one-half courses. (6 graduate units.) *Rosendahl*

## **German**

Professor Phelps, *Chairman and Director of Graduate Studies* (106 Language Building); Assistant Professor Bessent, *Director of Undergraduate Studies* (107 Language Building)

The work in German 1, 2, and 63 will be coordinated with listening and oral practice in the language laboratory.

#### **First Term**

**1. Elementary German.** Practice in understanding, speaking, reading, and writing. Classroom techniques are combined with those of the language laboratory. One laboratory course. *Bessent*. 11:20-12:40 and Tuesdays and Fridays, 2:00-3:20. 5.109

**63. Intermediate German.** Prerequisite: German 1-2 or 2 units of high school

German. One laboratory course. *Bessent*. 9:40-11:00 and Mondays and Thursdays, 2:00-3:20. 5.109

**182. German.** An intensive introduction to the language. Open only to students who have achieved proficiency in another language. *Alt*. 9:40-11:00. 5.08

**191. Independent Study.** Directed reading and research. Open only to qualified students in the junior year, by permission of the department. One course. *Staff*

**193. Independent Study.** Directed reading and research. Open only to qualified students in the senior year, by permission of the department. One course. *Staff*

### The Duke-Vassar Summer Program in Munster: Germany

Students can earn up to two courses for work taken in Munster: German 117 and 118 (Conversation) or one conversation course and German 127 (Contemporary German) or German 130 (German Life and Thought). No student may receive credit for both 127 and 130. For detailed information on the program, contact Professor Helga Bessent, Department of German, Duke University, Durham, N.C. 27706.

### Second Term

**2. Elementary German.** Practice in understanding, speaking, reading, and writing. Classroom techniques are combined with those of the language laboratory. Prerequisite: German 1 or equivalent. One laboratory course. *Alt*. 11:20-12:40 and Tuesdays and Fridays, 2:00-3:20. 5.08

**192. Independent Study.** Directed reading and research. Open only to qualified students in the junior year by permission of the department. One course. *Staff*. Hours to be arranged.

**194. Independent Study.** Directed reading and research. Open only to qualified students in the senior year by permission of the department. One course. *Staff*. Hours to be arranged.

## Health Administration

Professor Jaeger, *Chairman*, (262 Baker House); Assistant Professor Smith, *Director of Graduate Studies* (237 Baker House)

All courses extend throughout the summer session and are ordinarily closed to students in departments other than Health Administration.

**312. Comparative Health Systems.** A comparative examination of the structure and performance of the health systems of the United States and other countries, particularly Canada and Great Britain. Topics include current financing, capitalization, utilization, control, and the relative role of the governmental and private sectors. 2 units. *Falcone*

**321. Operations Research for Health Administration.** The development of a quantitative modeling framework derived from the concepts of the systems approach to analyze management decisions in health administration. The focus of the course is on the knowledge and skills needed to manage the analysis (i.e., formulation, assumption, interpretation, cost of analysis) rather than to perform the analysis. The process of analysis is emphasized over detail of techniques. Decisions are treated both deterministically and stochastically, and on a scale from simple to complex. Techniques that serve the framework include calculus, inven-

tory theory, PERT, decision analysis, fixed vs. variable cost analysis, queueing, simulation, and mathematical programming. Examples from the field are used extensively. The latter part of the course presents the concepts of quantitative control, with the same emphasis and again with examples from the field. 4 units. *Warner*

**324. Institutional Health Services.** A broad examination of the provision of health services in institutional settings. The principal focus is on the general hospital, but attention is also given to the mental hospital and other long-term care institutions. Specific study is made of the administrative and informational organization; the structure and function of each department; relationships between administration and the governing board, the medical staff, and the community; operational and capital financing; planning function; and the evaluation of performance. 4 units. *Blanks*

**326. Health Economics.** A study of the current state of knowledge with regard to the economics of health and medical care. Attention is given to the unique problems of demand and supply in the health services sector, as well as the implication of private and public financing alternatives; restrictions on man-power entry. Incentives and mobility; and problems of productivity measurement and changes. 2 units. *Cummins*

**371. Directed Research.** Individual studies by arrangement. Variable credit. *Staff*

## Health, Physical Education, and Recreation

Professor Friedrich, *Chairman* (105-A Card Gym); Associate Professor Skinner, *Director of Undergraduate Instruction* (106 Card Gym)

### First Term

**PE 15. Individual Development (Aerobics).** Aerobic conditioning activities with weight training, physical fitness exercises, and fundamental body building. One-half course. 11:20-12:40. *Buehler*.

**PE 15.2. Individual Development (Aerobics).** Aerobic conditioning activities with weight training, physical fitness exercises, and fundamental body building. One-half course credit. 8:00-9 20. *Riebel*

**PE 20. Beginning Swimming.** Basic fundamentals and strokes of swimming are taught. One-half course. 11:20-12:40. *Persons*. Card Gym

**PE 23. Kayaking.** Development of all phases of single kayaking. Pool, lake, and river experiences are provided. One-half course. To be arranged. *Harvey*

**PE 30. Beginning Golf.** Basic fundamentals and shots in golf are taught. Students use practice driving range and putting green as well as the Duke golf course. Fee required. One-half course. 9:40-11:00. *Myers*

**PE 32. Handball-Racketball-Squash.** 9:40-11:00 A.M. One-half course. *Skinner*

**PE 41. Intermediate Tennis.** Primary emphasis is on beginning and intermediate tennis strokes, fundamentals, and game strategy. One-half course. 9:40-11:00. *LeBar*

**PE 42. Advanced Tennis.** Review of all strokes with emphasis on strategy, placement, and competitive play concepts and skills. One-half course. 11:20-12:40. *LeBar*



**PE 163. Athletic Coaching in Secondary Schools.** (Track and Baseball.) Emphasis is given to the fundamentals and theory of coaching track and baseball. One course. 1:00-2:20. *Buehler*. 104 Card Gym

**PE 171. Recreational Administration Leadership.** Theories and philosophies of play and recreation with emphasis on leadership techniques with program administration and application to community organizations, school, and government sponsored programs. One course. 9:40-11:00. *Friedrich*. 104 Card Gym

**PE 172. The Administration of Health, Physical Education, and Athletics in Secondary Schools.** A study of the organization and administration of health, P.E. and athletic programs, facilities and staff is given. One course. 11:20-12:40. *Friedrich*

**PE 173. Protective Practices in Physical Education and Athletics.** Training and conditioning of athletic teams and the prevention, diagnosis, and treatment of athletic injuries. One course. 8:00-9:20. *Riebel and Ritz*. 104 Card Gym

## Second Term

**PE 15. Individual Development (Aerobics).** Aerobic conditioning activities with weight training, physical fitness exercises, and fundamental body building. One-half course. 11:20-12:40. *Buehler*

**PE 15.2. Individual Development (Aerobics).** Aerobic conditioning activities with weight training, physical fitness exercises, and fundamental body building. One-half course credit. 8:00-9:20. *Riebel*

**PE 20. Beginning Swimming.** Basic fundamentals and strokes of swimming are taught. One-half course. 8:00-9:20. *Persons*. Card Gym

**PE 25. Swimming and Life Saving.** In this course students may complete requirements to obtain Red Cross Life Saving Certificate. One-half course. 9:40-11:00. *Persons*. Card Gym

**PE 32. Handball-Racquetball-Squash.** 9:40-11:00. One-half course. *Skinner*

**PE 173. Protective Practices in Physical Education and Athletics.** Training and conditioning of athletic teams and the prevention, diagnosis, and treatment of athletic injuries. One course. 8:00-9:20. *Riebel and Ritz*. Card Gym

## History

Professor Durden, *Chairman* (235 Allen Building); Professor Young, *Director of Graduate Studies* (237 Allen Building); Professor Davis, *Director of Undergraduate Studies* (231 Allen Building)

### First Term

**21. Europe to the Eighteenth Century.** Development and world impact of European civilization; critical evaluation of historical interpretations; investigation of history from primary sources. One course. *di Corcia*. 8:00-9:20. 53.234

**54. Roman History.** (Also listed as Classified Studies 54.) One course. *Oates*

**91. Development of American Democracy to 1865.** A study of the trends vital to an understanding of the United States today. The main theme is the development of American democracy. Problems of foreign policy, the growth of capitalism, political practices, social reform, and conflicting ideals are considered in relation to this main theme. One course. *Nathans*. 9:40-11:00. 53.226

**158. The Rise of Modern Science.** The development of science and medicine

with attention to cultural and social influence upon science; eighteenth to twentieth centuries. One course. *Mauskopf*. 11:20-12:40. 53.226

**180. Bourbon, Revolutionary, and Napoleonic France.** Causes, patterns, and meanings of the Revolution; Napoleon's relation to Bourbon and Republican France and to Europe. One course. *di Corcia*. 9:40-11:00. 53.234

**283. Political and Social Change in the United States, 1789-1860.** One course. (3 graduate units.) *Nathans*. 11:20-12:40. 53.234

### Second Term

**22. Europe from the Eighteenth Century.** Development and world impact of European civilization; critical evaluation of historical interpretations; investigations of history from primary sources. One course. *Gordon*. 8:00-9:20. 53.234

**92. The Development of American Democracy, 1865 to the Present.** A continuation of History 91 with emphasis upon the emergence of contemporary problems in the United States. One course. *Hummer*. 9:40-11:00. 53.226

**164. The Origins of the New South, 1861-1900.** One course. *Ness*. 11:20-12:40. 53.226

**211. Comparative Study of Revolution.** An analysis of the causes and dynamics of the "Great Revolutions"—English, French, and Russian. One course. (3 graduate units.) *Cell*. 11:20-12:40. 53.234

**228. Recent United States History: Major Political and Social Movements since 1929.** One course. (3 graduate units.) *Ness*. 9:40-11:00. 53.234

### Third Term

**229. Recent Interpretations of Modern European History.** A course designed to develop the ability to appraise critical historical issues through the study and discussion of recent interpretations of key historical problems in modern European history. One course. (3 graduate units.) *Gunsburg*. 11:20-12:40. 53.234

**277. The Coming of the Civil War in the United States, 1820-1861.** One course. (3 graduate units.) *Durden*. 9:40-11:00. 53.234

## Management Sciences

Professor Keller, *Chairman* (115 Social Sciences Building); Professor Dickens, *Director of Undergraduate Studies* (203 Social Sciences Building)

### First Term

**50. Elementary Theory of Economic Enterprise.** Analysis of the internal resource allocation of the firm, market structures, and capital theory and the mathematical foundations for this analysis. Prerequisite: Mathematics 31. Not open to students who have taken Economics 2 or 52. One course. 8:00-9:20. 10.220

**53. Introductory Financial Accounting.** The accounting model of the firm and transactions analysis. Topics include the procedures used to process accounting data, issues in asset valuation and income determination, and financial statement analyses. Prerequisite: Mathematics 31. Corequisite: Management Science 40, or equivalent. 9:40-11:00. 10.220

**120. Analysis of Organizational Behavior.** The structure and behavior of organizations, with special reference to business firms. Topics include rationality, authority, bureaucracy; power, decision-making, informal organization, organization change; effects of technology, culture, and other environmental

influences. Prerequisite: Management Sciences 50. One course. 11:20-12:40. 10.220

**145. Federal Income Taxation.** Principles of federal income tax laws related to corporations and individuals. Tax planning and the effect of tax law on business decisions will be emphasized. Prerequisite: Management Science 53. 4 units. 8:30-10:10. 10.111

**231. Intermediate Financial Accounting.** Requirements of investors, auditors, unions, and governments for information about the status and operations of firms and a framework for disclosure of the relevant data. Prerequisite: Management Science 53. 4 units. 10:30-12:10. 10.111

## May 10-August 19

**385. Short and Long-Run Planning.** An integrated treatment of the functional areas of the firm in the context of short-run and long-run decision problems. Topics include: forecasting, cash management program budgeting, fund accounting, investment decisions in plant, equipment and product, choice of technology, cost of capital and taxes. 3 units. 8:30-9:20. 10.229

## Second Term

**110. Probability and Statistics.** Probability theory and distributions. Classical statistical analysis and its application to decision problems. Estimation, hypothesis testing, regression, and correlation analysis. Not open to students who have taken Public Policy Studies 112, Economics 138, Mathematics 53, or Engineering 150. Prerequisite: Mathematics 31. Corequisite: Management Science 50. One course. 8:00-9:20. 10.220

**137. Managerial Accounting.** The use of accounting information by management in short term planning, control, and decision-making in business enterprises. Cost accumulation, cost analysis, cost estimation, the development of standards, introduction to budgeting, and short run decision-making. Prerequisite: Management Science 53; Corequisite: Management Science 114. One course. 9:40-11:00. 10.220

**232. Internal Control and Auditing.** The independent auditor's examination of the accounting control system and other evidence as a basis for expressing an opinion on a client's financial statements. Basic audit objectives, standards, ethics, terminology, procedures, and reports. Prerequisites: Management Science 137, 231. 4 units. 8:30-10:10. 10.111

**234. Advanced Financial Accounting.** Accounting for and reporting on the diverse activity of multi-product, multi-divisional, multi-national organizations. Organizations with and without profit goals are studied. Prerequisite: Management Science 137, 231. 10:30-12:10. 10.111

## Mathematics

Professor Warner, *Chairman* (135-C Physics Building); Professor Weisfeld, *Director of Graduate Studies* (217-B Physics Building); Professor Murray, *Director of Undergraduate Studies* (131 Physics Building)

### First Term

**31. Introductory Calculus.** Limits, differentiation, and integration with applications to physical problems. Prerequisite: three years of college preparatory mathematics. One course. *Staff*. 11:20-12:40. 49.132

**53. Basic Statistics.** Principal statistical methods including application to psychological, economic, business administration, and educational problems. Techniques of data collection and presentation hypothesis testing, using the chi-square,  $t$ , and  $F$  distributions, interval estimation and linear regression. Not open to students who have had Economics 138 or Psychology 117. One course. *Staff.* 9:40-11:00. 49.132

### Second Term

**31. Introductory Calculus.** Limits, differentiation, and integration with applications to physical problems. Prerequisite: three years of college preparatory mathematics. One course. *Staff.* 9:40-11:00. 49.132

**32. Introductory Calculus.** Transcendental functions, sequences, series, Taylor's formula. Prerequisite: Mathematics 31. One course. *Staff.* 11:20-12:40. 49.132

**216. Intermediate Analysis.** Series: uniform convergence, integration. Theory of functions of a real variable. One course. (3 graduate units.) *Staff.* 8:00-9:20. 49.124

**220. Advanced Linear Algebra with Applications.** Solutions of systems programming and game theory; computation of eigenvalues and eigenvectors. One course. (3 graduate units.) *Staff.* 9:40-11:00. 49.124

### Third Term

**19. Pre-Calculus Mathematics.** Selected topics in algebra, trigonometry, and analytic geometry. Students with CEEB achievement scores in mathematics below 530 need this skill course before taking Mathematics 31. Prerequisite: two units of college preparatory mathematics. One course. *Staff.* 9:40-11:00. 49.124

**32. Introductory Calculus.** Transcendental functions, sequences, series, Taylor's formula. Prerequisite: Mathematics 31. One course. *Staff.* 11:20-12:40. 49.124

**226. Theory of Numbers.** Divisibility; congruences, Chinese Remainder Theorem; arithmetic functions. One course. (3 graduate units.) *Staff.* 9:40-11:00. 49.128

**271. Introductory Topology.** Set theory, metric spaces, topological spaces; separation axioms; connectedness; continuity; paracompactness. One course. (3 graduate units.) *Staff.* 11:20-12:40. 49.128

## Microbiology and Immunology

Professor Joklik, *Chairman* (414 Jones Building); Professor Willett, *Director of Graduate Studies* (420 Jones Building)

The department offers graduate work leading to the Ph.D. degree. Specialization is possible in molecular virology, viral oncology, cell biology, microbial physiology, medical mycology, immunochemistry, immunogenetics, cancer immunology, and general immunology.

Undergraduate preparation in biochemistry and physical chemistry is required. A brochure describing the Ph.D. degree program, prerequisites for admission, and research in the department can be obtained by writing the Director of Graduate Studies, Box 3020, Duke Medical Center.

### Second Term

**325. Medical Mycology.** Comprehensive lecture and laboratory coverage of



all the fungi pathogenic for humans. Practical aspects as well as future trends in the mycology, immunology, diagnosis, pathogenesis, and epidemiology of each mycotic agent will be explored. There will be several invited lecturers, each an internationally recognized scientist, discussing their particular areas of mycological expertise and current research. Prerequisite: consent of instructor. Enrollment limited to twenty. July 5-29, 1977. *Dr. Mitchell*. 8:30-12:00, Monday-Friday, Lectures, M-312 Davison; Laboratory, M-410 Davison.

## Music

Associate Professor Tirro, *Chairman* (105-C Biddle Music Building, East Campus); Assistant Professor Henry, *Director of Undergraduate Studies* (078 Biddle Music Building, East Campus)

### First Term

**125. Masterworks of Music.** Historical, biographical, and analytical study of works of major composers of the seventeenth through the twentieth centuries. One course. 8:00-9:20. *Henry*. E.104

**185. Seminar in Piano Literature.** Representative works of major keyboard composers from 1650 to the present. Some background in piano performance recommended but not essential. One course. 8:00-9:20. *Withers*

### Second Term

**179. Independent Study in Musical Performance.** Intensive coaching in operatic performance. Work in applied voice, vocal diction, operatic repertoire, and interpretation of scene study. One course. Hours to be arranged. *Hanks*

**181, 182. Independent Study in Musical Performance.** Intensive coaching and performance in chamber music at Kneisel Hall, Blue Hill, Maine. See Music Department for dates and fees. Two courses. *Mueller*

## Nursing

Professor Wilson, *Dean* (1005 School of Nursing); Assistant Professor Brundage, *Coordinator of Undergraduate Program* (1004 School of Nursing); Associate Professor Hall, *Coordinator of Graduate Program* (1004 School of Nursing)

### First Term

**121S. Parenthood.** An investigation of parenting behavior with a focus on the meeting of experiences to the mother and father and the means by which individuals can maximize the positive potential of these experiences. Prerequisite: consent of instructor. One course. Pass/fail option. *Harris*. 9:40-11:00. SN1046

**191, 192, 193, or 194. Independent Study.** Demonstration of self-direction in planning, implementing, evaluating, and reporting an independent learning experience. The required study for nursing majors must focus on nursing. Prerequisite: consent of instructor. Minimum one course. Pass/fail option. *Staff*

**244. Theories of Group Psychotherapy.** Theories of group psychotherapy based on psychoanalytic, interpersonal, communication, and group dynamic theories of psychiatry as pertinent to the practice of group psychotherapy by nurses. Exposure to and discussion of: differing models and types of group therapy, basic principles and techniques of group therapy, and the role of the psychiatric nurse in this treatment modality. Prerequisite: consent of instructor. Minimum one course or three units. *White*. Hours to be arranged.

**390. Clinical Practicum.** (Continued in Terms II and III.) Ten units. *Hogue*. Tuesday. Hours to be arranged.

**391, 392, 393. Independent Study.** An opportunity for the student to fit the curriculum to individual learning goals, both substantively and methodologically, and to demonstrate competence in self-directed learning.

### Second Term

**191, 192, 193 or 194. Independent Study.** (See description given in Term I.) *Staff*

**390. Clinical Practicum.** Continued from Term I. *Staff*

**391, 392, 393. Independent Study.** (See description given in Term I.)

**395 or 396. Master's Thesis.** *Staff*

### Third Term

**173. The Child with Diabetes: A Living-Learning Experience.** This practicum offers opportunity to care for ambulatory children with diabetes mellitus in a residential summer camp setting. The focus is on principles of diet, medication, and activity modification in management of labile juvenile diabetes and on facilitating self-care by the child with a chronic disease. Open to rising seniors in the nursing major. Also listed as MED-262 (C). One course. Pass/fail option. *Staff*. Hours to be arranged.

**191, 192, 193, or 194. Independent Study.** (See description given in Term I.) May be continued from Terms I and II. *Staff*

**390. Clinical Practicum.** Continued from Term I and II. *Staff*

**391, 392, or 393. Independent Study.** (See description given in Term I.) *Staff*

**395 or 396. Master's Thesis.** *Staff*

## Pathology

Professor Jennings, *Chairman* (M301 Davison Building); Professor Sommer, *Director of Graduate Studies* (M301 Davison Building)

### First Term

**357. Research.** Hours to be arranged. Prerequisite: consent of instructor. *Staff*

**361. Advanced General Pathology.** See *Bulletin of the Graduate School* for description. Prerequisite: consent of instructor. 6 units. *Staff*

### Second Term

**357. Research.** Prerequisite: consent of instructor.

**362. Advanced General Pathology.** Second part of Pathology 361. Prerequisite: consent of instructor.

### Third Term

**357. Research.** Hours to be arranged. Prerequisite: consent of instructor. *Staff*

## Philosophy

Professor Golding, *Chairman* (201-C West Duke Building, East Campus); As-

sociate Professor Roberts, *Director of Graduate Studies* (201-B West Duke Building, East Campus); Assistant Professor Ross, *Director of Undergraduate Studies* (201 West Duke Building, East Campus)

### First Term

**106. Philosophy of Law.** Natural law theory; legal positivism; legal realism; the relation of law and morality. One course. *Roberts.* 9:40-11:00. 9.129

**118. Philosophical Issues in Medical Ethics.** Ethical issues arising in connection with medical practice and research and medical technology. One course. *Roberts.* 11:20-12:40. 9.129

### Second Term

**48. Logic.** A study of the conditions of effective thinking and clear communication. Examination of the basic principles of deductive reasoning. One course. *Sanford.* 9:40-11:00. 9.129

### Third Term

**44S. Introduction to Philosophy.** Examination of problems in philosophy; emphasis on ethics and value theory. *Bamford.* 11:20-12:40. 9.129

## Physical Therapy

Associate Professor Branch, *Acting Co-Chairman and Director of Graduate Studies* (045 Hospital); Associate Professor Villaneuva

### First Term

**Research.** Credits and hours to be arranged.

### Second Term

**243. Directed Clinical Experience.** Credits and hours to be arranged.

**341. Advanced Seminar.** Credits and hours to be arranged.

### Third Term

**243. Directed Clinical Experience.** Credits and hours to be arranged.

## Physics

Professor Walker, *Chairman* (118 Physics Building); Associate Professor Evans, *Director of Graduate Studies* (112 Physics Building); Professor Roberson, *Director of Undergraduate Studies* (412 TUNL)

### First Term

**33. Energy: Principles, Problems, Alternatives.** Basic principles of physics as related to energy, the energy crisis, possible sources and alternatives, conservation, and environmental aspects of energy consumption. Optional special topics laboratory. No previous knowledge of physics assumed. One course. *Robinson.* 9:40-11:00. 49.113

**51. General Physics.** Basic principles of general physics treated quantitatively. Designed for students entering medicine, engineering, and the sciences. Not open for credit for students who have completed Physics 41, 42 in their freshman year. Prerequisites: Mathematics 31, 32, or equivalent (may be taken concurrently with consent of instructor). One laboratory course. *Evans.* 9:40-4:00. 49.114

## Second Term

**52. General Physics.** A continuation of Physics 51. Prerequisite: Physics 51. One laboratory course. *Evans*. 9:40-4:00. 49.114

## Third Term

**55. Introduction to Astronomy.** Man's evolving theory of the physical universe. Cosmological models, galaxies, stars, interstellar matter, the solar system, and experimental techniques and results. Optional observational laboratory. One course. *De Lucia*. 8:00-9:20. 49.113

**255. Astronomy for Teachers.** Observational techniques and the use of telescope. Evolution of planetary atmospheres and interiors, stellar evolution, galaxies, cosmology. Observatory observation. One course. *De Lucia*. 8:00-9:20. 49.113

## Physiology

Associate Professor Salzano, *Acting Chairman* (388 Nanaline H. Duke); Professor Ottolenghi, *Director of Graduate Studies* (453 Nanaline H. Duke) Associate Professor Padella, *Director of Undergraduate Studies*.

### Third Term (Marine Laboratory, Beaufort)

**212.** Physiology of marine and estuarine organisms, with emphasis on cellular transport processes and electrophysiology. The course also includes the functions, mechanisms, and comparative aspects of ionic and osmotic regulation in plants and animals. Laboratory work deals with membrane transport processes in single cells and epithelia, basic electrophysiology, permeability properties of synthetic membranes, renal and gill transport processes in fish and crustaceans, and the applications of radio-tracer and other physical and chemical techniques to the study of membrane function. Prerequisite: consent of instructor. One and one-half courses. (6 graduate units.) *Gutknecht*

## Political Science

Professor Barber, *Chairman* (214 Perkins Library); Associate Professor Johns, *Director of Graduate Studies* (214 Perkins Library); Professor Hall, *Director of Undergraduate Studies* (314 Perkins Library)

### First Term

**93. Elements of International Relations.** The nature of international politics, the analysis of national power, the instruments of foreign policy, and the controls of state behavior. One course. *Kruzel*. 1:20-2:40. 4.307

**204S. Ethics in Political Life.** Ethical issues arising in the conduct of political vocations and activities. (Also listed as Public Policy Science 204.) One course. (3 graduate units.) *Spragens*. 11:20-12:40. 4.307

**157. Foreign Policy of the United States.** Sources of American foreign policy, containment, international economic policy, deterrence, arms control, and disarmament. Prospects in the post-Vietnam era. Emphasis on the period since World War II. One course. *Holsti*. 9:40-11:00. 4.307

### Second Term

**122. Modern International Politics.** An examination of the major problems of post-war international politics with particular attention to the extension of Soviet



power, the Western response to this challenge, and the revolutions in the Afro-Asian world. One course. *Eldridge*. 1:20-2:40. 4.307

**163. Women in Developing Societies.** The diverse roles women played in Third World countries prior to European contact, the subsequent transformation under colonial rule, and the current reassessment by the governments of developing societies. One course. *O'Barr*. 11:20-12:40. 4.307

**210. The Politics of Education.** The forces in local, state, and national politics which impinge on educational policy-making and administration. Not open to students who have had Political Science 313. (Also listed as Education 210.) One course. (3 graduate units.) *Leach*. 9:40-11:00. 4.307

**Third Term**

**128. Congress and the Presidency.** Policy-making in the executive and legislative branches of the United States government, with particular attention to intra-governmental relations. One course. *Price*. 11:20-12:40. 4.307

**275. The American Party System.** An intensive examination of selected facets of American national political parties, such as relationships between presidential and congressional politics, the politics of national conventions, recent foreign policy and party alignments, and the controversy over party government. One course. (3 graduate units.) *Mishler*. 9:40-11:00. 4.307

**Psychology**

Professor Bevan, *Chairman* (312 Sociology-Psychology); Professor Staddon, *Director of Graduate Studies* (242 Sociology-Psychology); Professor Wing, *Director of Undergraduate Studies* (316 Sociology-Psychology)

**First Term**

**102. Sensation, Perception, and Learning.** Sensation, including psychophysics and receptor processes. The concept of reflex, both physiological (Sherington) and behavioral (Pavlov). Complex organization: learning, perception, and cognition. One course. *Lockhead*. 9:40-11:00. 10.219

**138. Abnormal Psychology.** Disordered behavior and constructive personality change are viewed in interpersonal and social context for purposes of understanding normal and abnormal personality development and functioning. Prerequisite: Psychology 104 or 105. One course. *Lakin*. 8:00-9:20. 9.127

**165S. Personality Theory.** Theories of personality from larger metatheoretical perspectives. Open to junior and senior majors in psychology, or by permission of the instructor. Prerequisite: Psychology 104. One course. *Lakin*. 9:40-11:00. 9.127

**Second Term**

**103. Biological Basis of Behavior.** Behavior as a product of evolution and the role of behavior in species survival. Neural and endocrine factors in reproduction, hunger, thirst, emotion, and intelligence. Heredity-environment in the development of behavior. One course. *Kalat*. 9:40-11:00. 9.130

**105. Developmental Psychology.** Theory and research on growth and behavior from infancy to adolescence. One course. *Eckerman*. 1:20-2:40. 9.130

**Third Term**

**104. Personality.** Representative theories of personality from Freud to the

present, emphasizing problems of normal personality structure, dynamics, development, and assessment. One course. *Carson*. 9:40-11:00. 9.130

## Religion

Professor Poteat, *Chairman* (117-B Gray); Professor Smith, *Director of Graduate Studies* (209A Divinity); Professor Osborne, *Director of Undergraduate Studies* (329 Gray)

### First Term

**52. The New Testament.** Origins, development, and thought. Not open to students who have had Religion 55 or 55D. One course. *Charlesworth*. 8:00-9:20. 3.220

**57. Introduction to Religions of Asia.** Problems and methods in the study of religion, followed by a survey of the historical development, beliefs, practices, and contemporary significance of the Islamic religion and religions of South and East Asia. One course. *Corless*. 11:20-12:40. 3.220

**188. Recent Literature and its Religious Implications.** Religious elements in recent literature. One course. *Kort*. 1:20-2:40. 3.220

### Jerusalem and the Galilee: Summer Session in Israel, 1977

The Department of Religion at Duke University and the Cooperative Program in Judaic Studies at Duke and the University of North Carolina at Chapel Hill will again offer an intensive summer program in Israel through the Duke Summer School. Duke students are recommended to take four courses in the eight week program. The Jerusalem Program will be conducted at the Jacob Hiatt Institute at Brandeis University. The program is open to undergraduates, divinity students, and graduate students.

### Program I

#### Courses in Jerusalem, May 23-June 17

Religion 195C: Seminar on Jerusalem: City and Symbol. *D. Halperin*  
Anthropology 129: Peoples of the Middle East. *L. Rosen*

#### Courses at Excavations at Meiron, June 19-July 22

Religion 131D: Principles of Archaeological Excavation. *E. Meyers*  
Religion 132D: Palestine in Late Antiquity. *E. Meyers*

The approximate cost of the program for students is \$2,350 for four courses. If there are fewer than twenty-two students enrolled by the date of departure the cost will be \$2,050 for three courses. This includes the round-trip air fare, with European stopover; tuition and fees; full-pension in Jerusalem; and full-pension at the excavations for five and one-half days a week. All cost projections are tentative and subject to revision. The current estimate, however, has projected all increases on the basis of available information. Air fare estimates are valid only until January 31, 1977.

### Program II (Dig only)

Excavations at Meiron, June 6-July 22

Courses: Religion 131D, 132D, or Religion 399 for graduate and divinity students.

The total cost for Program II is \$1,600 if fewer than twenty-two students have enrolled by the day of departure.

Applications and further information can be obtained from:

Summer in Israel Program, P. O. Box 4735, Duke University, Durham, N. C. 27706.

## Second Term

**111. The Historical Jesus.** Historical research on the life of Jesus. One course. *Price.* 8:00-9:20. 3.220

**142. Myth and Symbol.** Historical and phenomenological study of religious myths and symbols. One course. *Partin.* 9:40-11:00. 3.220

**195C. Junior-Senior Seminar: "Death and Dying."** One course. *Osborn.* 11:20-12:40. 3.220

## Third Term

**104. The Prophets of the Old Testament.** Their historical setting and message. One course. *Wintermute.* 9:40-11:00. 3.220

# Romance Languages

Professor Tetel, *Chairman* (205-A Languages Building); Associate Professor Vincent, *Director of Graduate Studies* (214 Languages Building)

## FRENCH

### First Term

**1. Elementary French.** Understanding, reading, and writing French. Language laboratory available for recording-listening practice. (Also equivalent to the Graduate Reading Course.) One course. *Bryan.* 9:40-11:00. 5.208

**100. Active French.** Conversation and exposés on contemporary subjects. Prerequisite: French 76 or consent of instructor. One course. *Bryan.* 11:20-12:40. 5.208

**141S. Creole Languages.** A study of the nature and origins of Creole languages, with special emphasis on the French-based Creoles of the Caribbean and the Indian Ocean. Tapes of Haitian Creole will be available for those wishing to learn that language. Prerequisite: French 74, 76 or equivalent. One course. *Hull.* 9:40-11:00. 5.217

### Second Term

**2. Elementary French.** Reading and writing French. One course. *Ripley.* 11:20-12:40. 5.219

**151. Theory and Form of Tragedy.** A study of major theorists and an analysis of principal Greek, French, and English tragedies. (Also listed as Comparative Literature 151.) One course. *Fowlie.* 8:00-9:20. 5.014. Graduate credit may be arranged.

# Spanish

### First Term

**1. Elementary Spanish.** Understanding, reading, and writing Spanish. Lan-

guage laboratory available for recording-listening practice. One course. *Staff*. 11:20-12:40. 5.211

**141S. Latin American Fiction: Theory and Practice.** A reading of contemporary texts in light of recent literary theory: Bioy Casares' *La invención de Morel*, Borges' *Ficciones*, Carpentier's *Los Pasos Peridos*, Cortazar's *Las armas secretas* and Fuentes' *La muerte de Artemio Cruz*; parallel selections on the theory of the novel and the short story. One course. *Santi*. 9:40-11:00. 5.305

## Second Term

**2. Elementary Spanish.** Reading and writing Spanish. Readings in modern literature. One course. *Staff*. 11:20-12:40. 5.211

**100. Active Spanish.** Conversation and written expression emphasizing oral communication. Prerequisite: Spanish 76 or consent of instructor. Enrollment limited to fifteen students. One course. *Staff*. 9:40-11:00. 5.208

## Duke Summer Program in Spain

**153S. Spanish Language and Culture.** One course. *Garci-Gómez*

**191 or 193. Independent Study.** Directed reading and research. One course. *Garci-Gómez*

## Science and Mathematics Institute for Teachers

These courses, for both prospective and practicing teachers, will be offered if demand is adequate. If interested, write immediately to Professor Sherwood Githens so that enrollments can be assessed at an early date. All but Chemistry 213-214 may be taken by a teacher who did not major in the named field, in order to broaden the preparation to teach. These courses may be applied toward the M.Ed. degree and the M.A.T. degree. Some state scholarships for tuition may be available to teachers under contract in a North Carolina public school. Chemistry 213 and 214 are applicable toward the Gifted and Talented Teaching Certificate.

## Second Term

**Chemistry 211-212. Environmental and Applied Chemistry for Teachers.** Study of modern chemistry with particular reference to environmental, ecological, and interdisciplinary aspects of modern technology. For teachers of biology, chemistry, and general science. Lecture, laboratory, field trips. 6 graduate units.

**Chemistry 213-214. Introductory Physical and Quantitative Chemistry: a Course for the AP Teacher.** Intensive study of major topics covered in the AP Chemistry course, including atomic and molecular structure, stoichiometry, elementary thermodynamics, chemical kinetics, electrochemistry, and physical chemistry of aqueous solutions. All day, five weeks, Monday through Friday, June 20-July 22. Lecture, laboratory, conferences. 6 graduate units. *Wilder*

## Third Term

**Physical Science 201, 202. Physical Science for Teachers, I and II.** Study of the major topics of introductory physics (I) and chemistry (II) with emphasis on laboratory work suitable for grades 9 through 12. Lecture and laboratory. 3 graduate units per course. *Githens*

See also Physics 255 (Astronomy) and Computer Science 251.

## Sociology

Professor Back, *Chairman* (268 Sociology-Psychology); Assistant Professor



Campbell, *Director of Graduate Studies* (254 Sociology-Psychology); Associate Professor Simpson, *Director of Undergraduate Studies* (253 Sociology-Psychology)

### First Term

**91. Introduction to Sociology.** One course. *Simpson* 9:40-11:00. 9.248

**150. The American Family.** The American family as an institutionalized group and its relationship with other institutions; the social psychology of family relations; variations by social class and ethnic group. One course. *Simpson*. 11:20-12:40. 9.248

### Second Term

**151. Sociology of Religion.** The religious factor in modern society and the social factor in modern religion. Major sociological theories and marginal religious groupings. One course. *Wilson*. 9:40-11:00. 9.248

### Third Term

**120. Perspectives on Deviant Behavior.** Development and distribution of deviant social behavior, treating such topics as social disorganization, stress and strain, cultural and labeling theories in relation to crime and delinquency, drug addiction, homosexuality, suicide, or others. (Not open to students who have taken Sociology 143.) One course. *Preiss*. 8:00-9:20. 9.248

**272. The Socialization Process.** Mechanisms and variations in socialization by position in the social structure (class, race, urban-rural); contributions made by various socialization agencies (family, school, peer groups, mass media) in Western society. One course. *Preiss*. 9:40-11:00. 9.248

## Zoology

Professor Fluke, *Chairman* (227 Biological Sciences); Associate Professor Wainwright, *Director of Graduate Studies* (024 Biological Sciences); Associate Professor Ward, *Director of Undergraduate Studies* (032 Biological Sciences)

The Department of Zoology manages a variety of programs tailored to individual needs of students seeking B.A., B.S., M.A., or Ph.D. degrees.

Students seeking undergraduate degrees should consult the *Bulletin of Undergraduate Instruction* for a statement of major requirements. A departmental handbook, available from the office of the Director of Undergraduate Studies, describes the advising system, typical courses of study, special programs, and interest and background of the faculty.

In general, graduate students entering the department will be equipped to pursue an advanced degree if they have completed an undergraduate major in biology, along with some formal training in college-level chemistry, mathematics, physics, and foreign languages.

Nevertheless, in recognition and support of the modern trend toward interdisciplinary research, the department is prepared to accept promising students with less orthodox academic backgrounds and is ready to encourage any student wishing to undertake a program of study leading, in effect, to an interdisciplinary degree sponsored by the department.

Thus, all students are urged to search widely in the *Bulletin of Undergraduate Instruction* and the *Bulletin of the Graduate School* for information about the intellectual resources of the University. Special attention, perhaps, should be given to announcements of the Department of Anatomy, Biochemistry, Botany, Chemistry, Geology, History, Mathematics, Microbiology and Immunology, Philosophy, Physics, Physiology and Pharmacology, Psychology, Sociology,

Anthropology, and Zoology; announcements of the Schools of Engineering and Forestry should also be consulted.

For registration dates see the General Registration section of this *Bulletin*. For detailed instructions and further information on the offerings at Beaufort, see the *Bulletin of the Duke University Marine Laboratory*.

### First Term (Durham campus)

**117. Genetics and Society.** An introduction to genetics with emphasis on the effects of environment and heredity upon the individual and the population. Students may not receive credit for both Zoology 117 and 180 or Nursing 105. Prerequisite: introductory biology or consent of instructor. One course. *Ward*. 9:30-11:10, Monday through Friday. 58.113

**191. Independent Study.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credit to be arranged. *Staff*

**193T. Tutorial.** For senior and junior majors with consent of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credit to be arranged. *Staff*

**353. Research.** To be carried on under the direction of the appropriate staff members. Hours and credits to be arranged. *Staff*

### First Term (Marine Laboratory, Beaufort)

**114L. Introduction to Biological Oceanography.** Physical, chemical, and biological processes that characterize the oceans, emphasizing special adaptations of organisms for life in the sea and factors controlling distribution and abundance of organisms. Not open to students who have had Geology 53 or Botany 53. Prerequisite: college biology. One and one-half courses. *Rowe*

**175L. Free-Living and Parasitic Invertebrates.** Lectures, readings, and laboratories: field trips to estuarine and marine habitats. Not open to students who have had Zoology 173, 174, or 274. Prerequisite: introductory biology. One and one-half courses. *Bookhout*

**191T. Tutorial.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Credits to be arranged. *Staff*

**193T. Tutorial.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credits to be arranged. *Staff*

**353.** Hours to be arranged. Prior approval of instructor at the Duke University Marine Laboratory required. (For graduate students only.) *Staff*

### Second Term (Durham campus)

**151L. Principles of Physiology.** An introductory survey. Prerequisites: introductory biology and Chemistry 12. One course.

**160L. Principles of Cell Biology.** Structure and function of organelles, metabolism, and regulatory mechanisms. Lectures. Prerequisites: introductory biology and Chemistry 12. One course. 9:30-11:10. Monday through Friday. 58.130 laboratory, 2:00-5:00, Monday through Wednesday. 58.048

**192. Independent Study.** For senior and junior majors with consent of the

Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credit to be arranged. *Staff*

**194T. Tutorial.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T and 194T maximum. Credit to be arranged. *Staff*

**354. Research.** To be carried on under the direction of the appropriate staff members. Hours and credits to be arranged. *Staff*

**Second Term (Marine Laboratory, Beaufort)**

**192T.** For senior and junior majors with consent of the Director of Undergraduate Studies and the supervising instructor. Course credit to be arranged. *Staff*

**194. Tutorial.** For senior and junior majors with consent of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credit to be arranged. *Staff*

**203L. Marine Ecology.** The application of ecological theory to marine systems. The mathematical properties of population growth and species interactions: field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current literature. Prerequisites: a course in general zoology or invertebrate zoology and calculus. Knowledge of statistics helpful. One and one-half courses. (6 graduate units.) *Sutherland*

**211. Mathematical Models in Biology.** Adaptation of physical laws to the description of biological phenomena. Prerequisites: One year of college mathematics and one course in statistics or consent of instructor. One and one-half courses (6 graduate units.) *Monroe*

**250L. Physiological Ecology of Marine Animals.** A study of the physiology of marine and estuarine animals in relation to certain environmental factors (temperature, salinity, oxygen, and light). Animals representing numerous phyla from various habitats are studied. Prerequisite: a course in physiology and general zoology. One and one-half courses. (6 graduate units.) *Forward*

**354. Research.** To be carried on under the direction of the appropriate staff members. Hours and credits to be arranged. *Staff*

**Third Term (Durham campus)**

**191. Independent Study.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credits to be arranged. *Staff*

**193T. Tutorial.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credits to be arranged. *Staff*

**353. Research.** To be carried on under the direction of the appropriate staff members. Hours and credits to be arranged. *Staff*

**Third Term (Duke Marine Laboratory, Beaufort)**

**191T.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Credits to be arranged. *Staff*

**193T. Tutorial.** For senior and junior majors with permission of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credits to be arranged. *Staff*

**214L. Biological Oceanography.** The impact of biological processes on the physical and chemical character of the environment and the regulating role of abiotic processes on organic productivity. The factors regulating primary and secondary productivity are studied using as examples the estuary and ocean adjacent to Beaufort. Emphasis is on the design and execution of directed research rather than lectures. Prerequisite: consent of instructor. Introductory biological or chemical oceanography recommended. One and one-half courses. (6 graduate units.) *Barber*

**274L. Marine Invertebrate Zoology.** Structures, functions, and habits of invertebrate animals under natural and experimental conditions. Field trips included. Not open to undergraduate students who have had Zoology 175 except with permission of the Director of Undergraduate Studies. Prerequisite: introductory biology. One and one-half courses. (6 graduate units.) *Barnes*

**278L. Invertebrate Embryology.** Lectures, readings, and laboratory work dealing with rearing, development, and life history of invertebrates. Prerequisite: consent of instructor. One and one-half courses. (6 graduate units.) *McClay*

**353. Research.** Hours to be arranged. Prior approval of instructor at the Duke University Marine Laboratory required. (For graduate students only.) *Staff*



## Calendar of the Summer Session

**First Term: May 10-June 11**  
**Second Term: June 13-July 15**  
**Third Term: July 18-August 19**

<b>March 28-31</b>	Preregistration of Duke students for summer and fall, 1977
<b>May 10</b>	Tuesday—Summer Session begins
<b>16</b>	Monday—First class day for chemistry and physics
<b>June 10</b>	Friday—Term I exams begin
Classes scheduled:	Examinations are:
8:00-9:20 a.m.	Friday, June 10, 9:00 a.m.-12:00 noon
1:20-2:40 p.m.	Friday, June 10, 2:00-5:00 p.m.
9:40-11:00 a.m.	Friday, June 10, 7:00-10:00 p.m.
<b>June 11</b>	Saturday—Term I ends (Term I exams end)
Class scheduled:	Examination is:
11:20-12:40 p.m.	Saturday, June 11, 9:00 a.m.-12:00 noon
<b>June 13</b>	Monday—Term II begins
<b>July 8</b>	Friday—Classes end in chemistry and physics
<b>14</b>	Thursday—Term II exams begin
Classes scheduled:	Examinations are:
8:00-9:20 a.m.	Thursday, July 14, 9:00-12:00 noon
1:20-2:40 p.m.	Thursday, July 14, 2:00-5:00 p.m.
9:40-11:00 a.m.	Thursday, July 14, 7:00-10:00 p.m.
<b>July 15</b>	Friday—Term II ends (Term II exams end)
Class scheduled:	Examination is:
11:20 a.m.-12:40 p.m.	Friday, July 15, 9:00 a.m.-12:00 noon
<b>July 18</b>	Monday—Term III begins
<b>August 18</b>	Thursday—Term III exams begin
Classes scheduled:	Examinations are:
8:00-9:20 a.m.	Thursday, August 18, 9:00 a.m.-12:00 noon
1:20-2:40 p.m.	Thursday, August 18, 2:00-5:00 p.m.
9:40-11:00 a.m.	Thursday, August 18, 7:00-10:00 p.m.
<b>August 19</b>	Friday—Term III ends (Term III exams end)
Class scheduled:	Examination is:
11:20 a.m.-12:40 p.m.	Friday, August 19, 9:00 a.m.-12:00 noon

## Directions to Summer Session Applicants

All applicants for summer session courses who are not now in residence at Duke University must fill out the application form accurately and in detail and return it to the Director of the Summer Session. Preference in enrollment will be given to persons returning the form promptly, but a place in a particular course cannot be assured until all fees are paid. Undergraduates or graduates who are enrolled in a university or college other than Duke University and who are seeking to transfer summer session credits to the college in which they are matriculated should request a course approval form to be certified by their dean or registrar. Graduate students are reminded that credit earned as an unclassified graduate student cannot be applied toward an advanced degree at Duke University. Persons applying for admission to the Graduate School of Duke University should write the Dean of the Graduate School for the necessary forms in addition to completing the application form in this *Bulletin*.

Undergraduates, both men and women, are required to live in the residence halls unless they are married or living with parents or relatives or have received permission to reside off campus for the previous or subsequent academic year. Any exception must be approved in advance by the Dean of Students.

Mail applications to Director of the Summer Session, 116 Allen Building, Duke University, Durham, North Carolina 27706.

# Application for Enrollment in the Duke University Summer Session

Mr., Ms. \_\_\_\_\_ (Please Print)  
Street Address, Rural Route, or P.O. Box \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_  
Social Security No. \_\_\_\_\_ Phone, Area \_\_\_\_\_ / \_\_\_\_\_

Please register me in the following courses listed in the *Bulletin of the Summer Session, 1976.*

Term	Dept.	Course. No.	Course Title
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Name and address of high school from which you graduated \_\_\_\_\_  
\_\_\_\_\_

Have you attended a college? Yes \_\_\_\_\_ No \_\_\_\_\_  
Name and address of college \_\_\_\_\_  
\_\_\_\_\_

Highest degree held \_\_\_\_\_  
Are you a candidate for a degree? Yes \_\_\_\_\_ No \_\_\_\_\_  
If yes, for which degree? \_\_\_\_\_

Circle the one below which indicates your present University status. (Do not indicate a status in a Duke University School or College unless you have already been admitted to that School or College.)

*Undergraduate Credits*

- Trinity College of Arts and Sciences
- School of Nursing
- School of Engineering
- Special or Unclassified
- Credits for Transfer

*Graduate Credits*

- Graduate School
- Divinity School
- School of Forestry
- Special or Unclassified
- Credits for Transfer

Are you applying for admission to the Duke Graduate School? \_\_\_\_\_  
Are you at present a college student? \_\_\_\_\_ If so, where? \_\_\_\_\_  
\_\_\_\_\_  
What class? \_\_\_\_\_

See Reverse

Are you a full-time teacher? \_\_\_\_\_

If so, give name and address of school and school system \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Teaching Position:

Elementary: \_\_\_\_\_

Secondary: \_\_\_\_\_

Administrator: \_\_\_\_\_

Supervisor: \_\_\_\_\_

Have you attended previous Summer Sessions at Duke? Yes \_\_\_\_\_ No \_\_\_\_\_

Years of attendance \_\_\_\_\_

Do you wish credit certified to some agency or school? Yes \_\_\_\_\_ No \_\_\_\_\_

If yes, please give exact name and address of agency or school \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Do you have any medical disabilities which would require special treatment or facilities?

Yes \_\_\_\_\_ No \_\_\_\_\_ Please explain \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Mail To: Director of the Summer Session  
116 Allen Building  
Duke University  
Durham, North Carolina 27706







## WEST CAMPUS 776

- |    |                  |     |                |
|----|------------------|-----|----------------|
| 1  | Davis, C. (1991) | 42  | Fox, D. (1981) |
| 2  | Davis, C. (1992) | 43  | Fox, D. (1982) |
| 3  | Davis, C. (1993) | 44  | Fox, D. (1983) |
| 4  | Davis, C. (1994) | 45  | Fox, D. (1984) |
| 5  | Davis, C. (1995) | 46  | Fox, D. (1985) |
| 6  | Davis, C. (1996) | 47  | Fox, D. (1986) |
| 7  | Davis, C. (1997) | 48  | Fox, D. (1987) |
| 8  | Davis, C. (1998) | 49  | Fox, D. (1988) |
| 9  | Davis, C. (1999) | 50  | Fox, D. (1989) |
| 10 | Davis, C. (2000) | 51  | Fox, D. (1990) |
| 11 | Davis, C. (2001) | 52  | Fox, D. (1991) |
| 12 | Davis, C. (2002) | 53  | Fox, D. (1992) |
| 13 | Davis, C. (2003) | 54  | Fox, D. (1993) |
| 14 | Davis, C. (2004) | 55  | Fox, D. (1994) |
| 15 | Davis, C. (2005) | 56  | Fox, D. (1995) |
| 16 | Davis, C. (2006) | 57  | Fox, D. (1996) |
| 17 | Davis, C. (2007) | 58  | Fox, D. (1997) |
| 18 | Davis, C. (2008) | 59  | Fox, D. (1998) |
| 19 | Davis, C. (2009) | 60  | Fox, D. (1999) |
| 20 | Davis, C. (2010) | 61  | Fox, D. (2000) |
| 21 | Davis, C. (2011) | 62  | Fox, D. (2001) |
| 22 | Davis, C. (2012) | 63  | Fox, D. (2002) |
| 23 | Davis, C. (2013) | 64  | Fox, D. (2003) |
| 24 | Davis, C. (2014) | 65  | Fox, D. (2004) |
| 25 | Davis, C. (2015) | 66  | Fox, D. (2005) |
| 26 | Davis, C. (2016) | 67  | Fox, D. (2006) |
| 27 | Davis, C. (2017) | 68  | Fox, D. (2007) |
| 28 | Davis, C. (2018) | 69  | Fox, D. (2008) |
| 29 | Davis, C. (2019) | 70  | Fox, D. (2009) |
| 30 | Davis, C. (2020) | 71  | Fox, D. (2010) |
| 31 | Davis, C. (2021) | 72  | Fox, D. (2011) |
| 32 | Davis, C. (2022) | 73  | Fox, D. (2012) |
| 33 | Davis, C. (2023) | 74  | Fox, D. (2013) |
| 34 | Davis, C. (2024) | 75  | Fox, D. (2014) |
| 35 | Davis, C. (2025) | 76  | Fox, D. (2015) |
| 36 | Davis, C. (2026) | 77  | Fox, D. (2016) |
| 37 | Davis, C. (2027) | 78  | Fox, D. (2017) |
| 38 | Davis, C. (2028) | 79  | Fox, D. (2018) |
| 39 | Davis, C. (2029) | 80  | Fox, D. (2019) |
| 40 | Davis, C. (2030) | 81  | Fox, D. (2020) |
| 41 | Davis, C. (2031) | 82  | Fox, D. (2021) |
| 42 | Davis, C. (2032) | 83  | Fox, D. (2022) |
| 43 | Davis, C. (2033) | 84  | Fox, D. (2023) |
| 44 | Davis, C. (2034) | 85  | Fox, D. (2024) |
| 45 | Davis, C. (2035) | 86  | Fox, D. (2025) |
| 46 | Davis, C. (2036) | 87  | Fox, D. (2026) |
| 47 | Davis, C. (2037) | 88  | Fox, D. (2027) |
| 48 | Davis, C. (2038) | 89  | Fox, D. (2028) |
| 49 | Davis, C. (2039) | 90  | Fox, D. (2029) |
| 50 | Davis, C. (2040) | 91  | Fox, D. (2030) |
| 51 | Davis, C. (2041) | 92  | Fox, D. (2031) |
| 52 | Davis, C. (2042) | 93  | Fox, D. (2032) |
| 53 | Davis, C. (2043) | 94  | Fox, D. (2033) |
| 54 | Davis, C. (2044) | 95  | Fox, D. (2034) |
| 55 | Davis, C. (2045) | 96  | Fox, D. (2035) |
| 56 | Davis, C. (2046) | 97  | Fox, D. (2036) |
| 57 | Davis, C. (2047) | 98  | Fox, D. (2037) |
| 58 | Davis, C. (2048) | 99  | Fox, D. (2038) |
| 59 | Davis, C. (2049) | 100 | Fox, D. (2039) |
| 60 | Davis, C. (2050) | 101 | Fox, D. (2040) |
| 61 | Davis, C. (2051) | 102 | Fox, D. (2041) |
| 62 | Davis, C. (2052) | 103 | Fox, D. (2042) |
| 63 | Davis, C. (2053) | 104 | Fox, D. (2043) |
| 64 | Davis, C. (2054) | 105 | Fox, D. (2044) |
| 65 | Davis, C. (2055) | 106 | Fox, D. (2045) |
| 66 | Davis, C. (2056) | 107 | Fox, D. (2046) |
| 67 | Davis, C. (2057) | 108 | Fox, D. (2047) |
| 68 | Davis, C. (2058) | 109 | Fox, D. (2048) |
| 69 | Davis, C. (2059) | 110 | Fox, D. (2049) |
| 70 | Davis, C. (2060) | 111 | Fox, D. (2050) |
| 71 | Davis, C. (2061) | 112 | Fox, D. (2051) |
| 72 | Davis, C. (2062) | 113 | Fox, D. (2052) |
| 73 | Davis, C. (2063) | 114 | Fox, D. (2053) |
| 74 | Davis, C. (2064) | 115 | Fox, D. (2054) |
| 75 | Davis, C. (2065) | 116 | Fox, D. (2055) |
| 76 | Davis, C. (2066) | 117 | Fox, D. (2056) |
| 77 | Davis, C. (2067) | 118 | Fox, D. (2057) |
| 78 | Davis, C. (2068) | 119 | Fox, D. (2058) |
| 79 | Davis, C. (2069) | 120 | Fox, D. (2059) |
| 80 | Davis, C. (2070) | 121 | Fox, D. (2060) |
| 81 | Davis, C. (2071) | 122 | Fox, D. (2061) |
| 82 | Davis, C. (2072) | 123 | Fox, D. (2062) |
| 83 | Davis, C. (2073) | 124 | Fox, D. (2063) |
| 84 | Davis, C. (2074) | 125 | Fox, D. (2064) |
| 85 | Davis, C. (2075) | 126 | Fox, D. (2065) |
| 86 | Davis, C. (2076) | 127 | Fox, D. (2066) |
| 87 | Davis, C. (2077) | 1   |                |

## MEDICAL CENTER 7500

- 1 Gerontology (JG)
- 2 O & T (JC)
- 3 Clinical Research (JC)
- 4 Merit Enhancement to Hospital (JC)
- 5 Clinical Research (JC)
- 6 Specialized Services (JC)
- 7 General Medicine (JC)
- 8 Diet/Bldg (JG)
- 10 Mass Access (JG)
- 11 Masses House (JG)
- 31 Est. Center (JG)
- 32 Shaw & Wood Bldg (JG)
- 34 2212 E. 1st. Rm (JG)
- 34 2212 E. 1st. Rm (JG)
- 36 Sub Station (JG)
- 38 M. C. Paving Structure (JG)
- 39 Nursing School Addition (JG)
- 41 Employee Bldg. Addition (JG)
- 42 Memorial Addition (JG)
- 44 Memorial Addition (JG)

## EAST CAMPUS 734

- 1 East Dura Bldg. (12C)
- 2 West Dura Bldg. (12C)
- 3 Aycock Residence Hall (12C)
- 4 Jarvis Residence Hall (12C)
- 5 Edworth Hall (12C)
- 50 Wareham Bldg. (12D)
- 51 Art Bldg. (12A)
- 54 Healing Pkgs. (12D)
- 55 Penit Shop & Storage Bldg. (12D)
- 56 Purchasing & Storage Bldg. (12D)

<sup>48</sup> Edwin L. Jones Bldg./MS.

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# Bulletin of Duke University

Marine Laboratory  
Beaufort, North Carolina

1977-1978





# Bulletin of Duke University

Marine Laboratory

1977-1978

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# General Information





## The Laboratory

Through the efforts of Dr. A. S. Pearse, the Duke University Marine Laboratory was founded in 1938 on Pivers Island near the town of Beaufort, North Carolina. It was established initially to offer teacher training at the senior-graduate level, but research soon became an integral part of the program. Studies are currently being conducted in the fields of ecology, systematics, physiology, embryology, mycology, algology, and biological, chemical, geological, and physical oceanography. In addition to the graduate program, a newly established interdisciplinary program in the marine sciences now makes it possible for qualified undergraduates to spend the spring semester at the Laboratory.

The Duke University Marine Laboratory presently occupies fifteen acres of the southern portion of Pivers Island; the U. S. Department of Commerce, NOAA, National Marine Fisheries Service, Center for Menhaden Research are located on the remainder of the island.

The physical plant consists of twenty-four buildings including five dormitories, a large dining hall, one residence, boathouse, storehouse for ship's gear, classroom laboratories, seven research buildings, and a maintenance complex. The research laboratories and five dormitories are heated, and three dorms are air-conditioned, thereby providing favorable conditions for year-round research.

Pivers Island is only 150 yards across the channel from the town of Beaufort. A bridge leads to U. S. Highway 70, so that the island is readily accessible by automobile. Transportation to the Laboratory consists of: bus service to Beaufort, Wheeler Airline service to Beaufort, and Piedmont Airlines to New Bern, forty miles from Beaufort.

The Beaufort area is well known for its moderate climate during the summer. Air temperatures range from an average minimum of 70° F. to an average maximum of 86° F. There is a prevailing southwest breeze from the ocean during most of the summer. Water temperatures range from 22-29° C. in June and from 24-30° C. during August.

Students should bring clothes suitable for field work including a sun hat, tennis shoes, bathing suit, shorts, work gloves, and sunglasses.

There are ample opportunities for recreation in and around Beaufort for swimming, fishing, boating, and water-skiing. On campus there are recreational facilities for swimming, rowing, sailing, shuffleboard, volleyball, croquet, and table tennis.

# Resources for Study







## Flora and Fauna

Beaufort is approximately midway between Woods Hole, Massachusetts, and Miami, Florida, in an area within the range of both the northern and southern species of biota. The edge of the Gulf Stream system is about thirty-five miles offshore, and between it and the shore occasional reefs are found.

The Beaufort area is strategically located for biological research because of the richness of its flora and fauna, and the ease with which one may reach many diverse habitats. From the Laboratory, by boat or automobile, the ocean, Cape Lookout and the Outer Banks, Bogue and Core Sounds, Harkers Island, rivers, creeks, canals, mud flats, sand beaches, dunes, marshes, peat bogs, cypress swamps, bird islands and rookeries, and coastal forests are readily accessible. Long leaf pine, yaupon, and at least seven species of insectivorous plants (protected by law), including the Venus flytrap, grow in the region. A great variety of algae, both fresh water and marine, is also available for study. Common animals include the king crab, squid, shrimps, snails, clams, ctenophores, jellyfish, hydroids, sponges, polychaetes, sea urchins, starfish, brittle stars, sand dollars, skimmers, terns, gulls, herons, sea turtles, porpoises, and many different types of fish.

## Research Interests

Much of the early research at the Marine Laboratory consisted of determining the distribution of plants and animals within the varying environments of the Beaufort estuary. With the addition of the Cooperative Oceanographic Program and the expansion of year-round activities, the general theme of the relationships of animals and plants to their environment has been broadened to include all segments of the estuarine and oceanic environments. Year-round research by resident staff, associates, visiting staff, and graduate students generally falls into five broad disciplines: biochemistry, developmental biology, oceanography, physiology, and systematics-ecology.

**Biochemistry.** The primary emphasis in the biochemical studies involves research on the structure, function, and evolution of protein molecules. Proteins, especially those involved in the transport of molecular oxygen (hemoglobin, hemocyanin, chlorocruorin, and hemerythrin), are being isolated and their structural and functional properties elucidated. These studies are intended to illustrate how protein molecules function, as well as how they have evolved. A major interest is how proteins are involved in adaptive processes. From comparative studies one can illuminate structure-function relationships and derive data on phylogenetic significance. Studies of protein polymorphisms are intended to illustrate gene flow among populations and offer insights into the adaptive strategies of marine organisms.

**Developmental Biology.** Much of the research in developmental biology deals with the culture of invertebrate larvae under controlled conditions in the laboratory, from hatching until the juvenile stages are reached. The availability of numerous larvae of known species, age, and stage of development has led to studies on the extent to which environmental factors within the marine environment affect rates of development, survival, and morphological abnormalities. In addition to studying the effects of natural environmental factors, research is under way to determine the effects of pollutants on larval development of marine crustacea. The developmental biology program also includes studies on the physiology of crustacean larvae and the factors involved in regulation of molting, rate of development, and metamorphosis during larval development.

**Oceanography.** Within the Oceanography Program, research is being conducted to examine the physical and biological dynamics of marine ecosystems which are enriched by upwelling, including the Coastal Upwelling Ecosystems Analysis Program, a multi-university and multi-ship field experiment concentration on the northwest African coast upwelling. Other interests include the effect of metal and dissolved organic interactions on the biological productivity of the upwelling system and the measurement and modeling of carbon productivity of the ecosystems. Research is also under way on the rate of recycling of sewage sludge and the impact of sewage disposal on marine systems, the chemical form and biological reactivity to toxic and essential metals as determined by electron paramagnetic resonance, the ability of phytoplankton to synthesize coordination compounds that form complexes with metals and alter their biological reactivity, and the isolation and identification of hydoroamic acids suspected of being responsible for the biogenic conditioning of seawater.

Chemical studies are aimed at understanding metal transport in terms of speciation as measured by anodic stripping voltammetry, electrophoresis, and ion exchange. *In vivo* effects of heavy metals on algal membranes are being described by general metal-organic associations. The degree of metal complexation has been measured over the Cape Fear Estuary and is being used to interpret rates of adsorption and desorption of metals in sediment and settling particulate matter. Gas chromatography is being used to assess anthropogenic changes in the mixture of organics in seawater. Studies of the alteration of these organic pools will facilitate the solution of problems concerned with the release and complexation of metals that are in delicate balance with our biological and geochemical systems.

Geological research programs include sedimentology, submarine topography, paleontology, and geophysics. Sedimentological investigations are primarily concerned with processes of continental margin sedimentation, largely within the Carolina continental shelf slope and rise, and also in certain deep basins in the vicinity of the Bahama Banks. Studies are concerned with the origin of postdeath shell coloration and the sediment distribution and sedimentary processes on the Cape Hatteras sediment plume, characterization of the continental rise and the relative importance of bottom currents versus gravity flows in forming the rise, and delineation of individual sorting effects. Additional research involves sea floor topography, including contouring and diagramming continental and insular margins with emphasis on the distribution and patterns of submarine canyons. Geomorphic studies are also under way in support of investigations in the Caribbean.

Paleontological studies are focused on the evolution of marine microzooplankton. Thick accumulations of deep-sea sediments are examined in order to determine trends in skeletal microphology which have occurred over the past fifty million years. Additionally, the biogeography of modern populations is studied in order to provide a framework for paleoclimatic investigations of the

past 100,000 years. In the fall of 1976, a new geophysical program will be initiated. Crustal structures deep below the sea floor of the Mediterranean and eastern Pacific will be studied by seismic refraction.

**Physiology.** In the realm of physiological studies, one primary interest involves studies on the photobiology of organisms in the marine environment, with emphasis on behavioral orientation to light. This involves determining the responses of a variety of marine organisms (unicellular dinoflagellates, larval crustaceans, and fish) to light, both in the natural environment as well as in the laboratory. Primary attention is on the identification of the light receptive pigments participating in the responses and the circadian rhythm of these responses. Accordingly, phototaxis is used as a model system for studying the basic physiology of rhythms.

A second area of interest is in membrane physiology and osmoregulation. The mechanisms and functions of salt and water transport in marine plants and animals are being studied. Specific interests include the mechanisms of osmotic regulation in giant algal cells and the role of the urinary bladder, gills, and gut in osmoregulation of fish. In conjunction with our studies on marine plants and animals, we are also studying the transport properties of synthetic lipid bilayer membranes. Specific interests include the effects of carbonic anhydrase on CO<sub>2</sub> transport, facilitated diffusion of salicylates and other drugs, and the effects of antidiuretic hormone, calcium, and membrane fluidity on water permeability of lipid bilayers.

**Systematics-Ecology.** Research in the Systematics-Ecology Program involves studies on community structure, benthic algae, and distribution of certain marine species off the North Carolina coast, and experimental phycology and phytoplankton systematics.

The major objective of studies on community structure is to identify and understand the processes which result in the temporal and spatial patterns in species abundance in some subtidal, epibenthic communities. Changes in the adult populations are followed with mapping and photographic techniques. The approach is experimental to the extent that species can be removed or excluded from the community to assess their importance in community structure and function. An eventual goal is the development of a systems model incorporating the basic community processes to provide the basis for predicting the deliberate or accidental effects of man's perturbations of these communities.

As part of this continuing research program, a seawater laboratory has been constructed to investigate the influence of thermal addition on community structure and the physiological ecology of individual species.

In part because the middle Atlantic coast is a meeting ground for the cool water species typical of northern shores and the warm water species of the Caribbean, studies include the determination of the distribution, phenology, and systematics of benthic algae off the coast of North Carolina. This work includes efforts to determine community structure and productivity in the different portions of Onslow Bay and to extend the studies north and south along the entire coast. A second aspect of the work is a descriptive study of the epiphytic algae which grow in the sounds on the blades of eelgrass and other marine angiosperms. In experimental phycology and phytoplankton systematics, the program of research comprises several related major areas particularly concerned with the biology of the algal class Haptophyceae (coccolithophorids and others). Experimentally oriented systematics investigations of marine phytoplankton are concerned primarily with life cycles and morphological variation. Ultrastructural and physiological research emphasizes the intracellular deposition of calcium carbonate into coccoliths—their formation, regulation, and relationships to



other cellular processes. Another line of physiological and biological oceanographic research is concerned with growth and calcification of phytoplankton in very dim light and darkness in an attempt to elucidate naturally occurring deep-sea populations.

Additional studies are being conducted to investigate the growth rates and development of suspension feeders in relation to temperature, size of the animals, concentration of suspended material, and the relative concentration of phytoplankton in suspension. These experiments involve natural seawater in a continuous flow system in which the concentration of phytoplankton can be monitored. The results suggest that the conditions under which maximum energy transfer occurs between primary producers and a primary consumer, facilitate the future exploitation of scallops, oysters, and other similar species.

The ramifications in estuarine waters of converting swamp-forests into intensive agriculture are being investigated as a large corporate farm develops near the Marine Laboratory. In addition to providing basic information on the functioning of an estuary which receives coastal swamp water, the results of the research are being used by farm management and regulatory agencies, and serve as a model for future decisions on agricultural/estuarine development.

## Research Facilities

**Laboratory Equipment and Supplies.** Visiting investigators may obtain research space throughout the year. Each research laboratory building is air-conditioned and equipped with running seawater through a P.V.C. system. There are tanks, water tables, aquaria, autoclaves, ovens, and plant presses. In addition to commonly used laboratory equipment, the following are available: two refrigerated centrifuges with multi-speed attachments, Beckman DU spectrophotometer, balances, pH meters, hoods, and constant temperature equipment. Students are expected to supply their own optical equipment or other special apparatus needed. A list of equipment, chemicals, and glassware may be obtained upon request. The Laboratory also maintains darkrooms, a well-equipped workshop, and a stockroom/purchasing department.

**Research Facility.** A three-story modern research laboratory, the C. G. Bookhout Research Laboratory, was completed early in the summer of 1972. Each room is well lighted artificially and all exterior rooms also receive natural light. Most rooms have a view of the water surrounding some part of Pivers Island. All rooms are air-conditioned and heated electrically so that the temperature of each room can be controlled to suit the needs of the occupant. Hot and cold water, air, gas, and vacuum are available in most rooms. the non-metallic seawater system is especially designed to reduce silt and fouling. The general arrangement of rooms on each floor provides for a core of rooms in the center of the building which are for general use and research rooms of different sizes are at the periphery of the building. Although the rooms on all three floors were designed for special purposes, they may be used for research in a variety of disciplines.

**Oceanographic Study.** The 117.5-foot research vessel *Eastward* with a capacity for forty students on eight-hour cruises or fourteen students and staff on extended cruises may be used for oceanographic research. During the present year, the ship will operate in the Atlantic Ridge, the Caribbean Sea, and the Peruvian coast. It is outfitted with modern recording and collecting devices and is available to investigators and teachers of graduate courses in marine sciences and their students. Application for ship time must be made in advance. Inquiries should be addressed to the Oceanographic Program Director, Duke University Marine Laboratory, Beaufort, North Carolina 28516.



In addition to the *Eastward* the Marine Laboratory has a new research vessel, the *John de Wolfe II*. This steel vessel is sixty-two feet long, has a nineteen and one-half foot beam and draws nine feet of water. It is equipped for long-line fishing and for near shore and offshore sampling. The vessel now sleeps four scientists plus crew and expects to add berths for six additional persons by mid-1977. Application for ship time must be made in advance. Inquiries should be addressed to: Coordinator, R/V *John de Wolfe II*, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

**Collecting.** Spades, shovels, sieves, and nets are provided without charge to assist investigators with their collecting. A wide assortment of boats is available for various collecting activities. A complete schedule of boats and charges may be found in the section on financial information. Information on species availability and collecting sites is available from the Curator of the Reference Collection.

**I. E. Gray Library-Auditorium.** This facility is air-conditioned, electrically heated, and has stack space for 18,500 volumes on the first floor. A second floor is intended for future expansion. Located in the building are the librarian's office, a room for duplicating machines, a receiving room, a kitchenette, two seminar rooms, and two closed carrels.

The building houses the Pearse Memorial Library which contains 4,250 catalogued reference books and journals, 150 current journals, and 1,720 reprints. There are also expedition reports in oceanography, a microfilm library of graduate student theses based on research at the Laboratory, a microfilm reader, and an A.B. Dick copier. Other materials may be obtained by a special delivery system from the Perkins Library on the Durham Campus or through the inter-library loan service with other libraries in the United States.

The auditorium has a seating capacity of approximately 300 and is suitable for lectures, seminars, symposia, and small regional or national meetings.

**Reference Collections.** A reference collection of approximately 1,500 different species of animals from coastal North Carolina is available to students and research personnel. Small collections of marine algae and vascular flora are also maintained, as well as a checklist by habitat of the common marine animals.

**Computing Facilities.** A PDP 11/10 digital computer with RK-11 Disk and TA11 Dual Cassette is available for general student and staff use. It has a 28-K core memory bank and uses BASIC, a conventional, on-line language similar to FORTRAN. The input-output devices are an LA30 DEC writer and a 4012 Tektronix Display Terminal.

**Electron Microscope.** The electron microscope laboratory comprises a microscope room housing an RCA EMU-3F transmission electron microscope, a photographic darkroom, a sectioning room housing a Porter Blum MT2-B ultramicrotome and light microscopes, and a preparation room with fume hood, vacuum evaporator, etc. The facility is available to qualified users; however, requests for microscope time must be made in advance. Address inquiries to: Director, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

**Scanning Electron Microscope.** A JSM-35 scanning electron microscope was set up as a demonstration unit by JEOL Inc. for the month of July, 1976. One week of instruction was provided by the company and the microscope was available to all qualified users for a period of three weeks. In addition to its function as a short-term teaching-research tool, this demonstration was intended to canvass potential usership in anticipation of an eventual purchase. A similar demonstration is planned for next year.

# Financial Information





## Summer Terms

Term I begins May 10 to June 11

Term II begins June 13 to July 15

Term III begins July 18 to August 19

### DEPOSIT

Upon acceptance into a course, a deposit of \$20 is required to ensure a reservation in that course.

### TUITION

The following are tuition charges for summer registration:

1. Undergraduate students: \$288 for each nonlaboratory course; \$384 for each undergraduate laboratory course; and \$576 for each one and one-half course (6 unit) program offered at the Duke University Marine Laboratory.

2. Graduate students: \$96 per unit. For an undergraduate course, the tuition rate indicated in section 1 above is applicable.

3. Full-time teachers in elementary and secondary schools: one-half of the tuition charge specified in sections 1 and 2 above is applicable.

The Director of the Duke University Marine Laboratory will notify the applicant of course approval. Tuition should be paid promptly to the Business Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

### STUDENT HEALTH

The costs of student health benefits have been borne by tuition in the past, but are now separate and can be identified as a medical expense for tax purposes.

All regular full-time undergraduate students (those registered for three courses or more) and all regular full-time graduate and professional students (those registered for nine units or more and for three units if the preliminary examination has been passed) are required to pay the health fee that is non-refundable after the first day of classes in the semester. In addition, all summer session students are required to pay a student health fee for each summer term. Graduate students, registered for summer research but not taking summer term courses, are required to pay an inclusive summer student health fee. The only exceptions to this requirement are for the following reasons: (1) if covered by a spouse's or parents' Duke University employee Blue Cross-Blue Shield insurance or (2) if eligible for and elect to use the V.A. Hospital services.



## LIVING ACCOMMODATIONS

**Room and Board.** Air-conditioned and a few non-air-conditioned dormitory rooms are available. Although every effort is made to have only two people per dormitory room, a few triple rooms may be needed to accommodate all individuals requiring dormitory space. Prospective students should indicate their preference for housing on the application for enrollment. It is impossible to guarantee that these preferences will be available in all cases.

Occupants must supply their own linens, blankets, and towels, but pillows will be furnished. A key deposit of \$5 will be charged each person occupying a dormitory room. This deposit will be refunded at time of departure.

Full board provides for three meals a day, Monday through Saturday, and breakfast and noon dinner on Sunday. There will be no credit allowed for missed meals.

Total fees for room and board will range between \$255 and \$275 per term depending upon the dormitory room assignment.

**Estimated Term Costs.** Estimated cost for each of the summer terms will be:

Tuition	(see tuition section)
Student Health	\$12
Room and Board	\$255—\$275

Books, if required by the instructor, will be available at registration.





## Spring Term

**Tuition.** Tuition for the spring term will be \$1,615 payable either at registration or by mailing a check to the Business Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516 upon acceptance for the term.

**Student Health.** (See information in the section on Summer Terms.)

**Room and Board.** All dormitory occupants must supply their own linens, blankets, and towels, but pillows will be furnished. A key deposit of \$5 will be charged each person occupying a room. This deposit will be refunded at time of departure.

Full board provides for three meals a day, Monday through Friday, and breakfast and noon dinner on Sunday. No credit will be allowed for meals that are missed.

Total room and board fee will be \$800 for the term.

**Estimated Term Costs.** Estimated costs for the spring term will be:

Tuition	\$1615
Student Health	\$35
Room and Board	\$800

Books, if required by the instructor, will be available at registration.

## Late Registration

Late registration fees will be charged in accordance with Duke University policy unless registration is completed and all fees paid by the last day of registration for the term.

## Refunds

**Refund for Tuition and Fees.** Tuition and fees will be refunded under the following circumstances:

1. When notifications of withdrawal are received by the Director of the Duke University Marine Laboratory before the first class day of a given term of the Summer Session, full tuition and fees will be refunded.

2. When applications for withdrawal are received by the summer session Office at the Marine Laboratory during the first four class days of a given term, 80 percent of the tuition and fees will be refunded.

3. When applications for withdrawal are received by the Summer Session Office at the Marine Laboratory after the fourth class day, there will be no refund of tuition and fees.

## Other Financial Information

**Room and Board Costs.** All Duke University Marine Laboratory visitors who stay on the island will pay a room and board fee of \$10 per day. Allowances will be made for partial days' stay and to permit an occasional evening meal at local restaurants.

**Boat Rentals.** The following boats are available at the Laboratory for collecting and instructional activities. Charges apply to all research activities and all non-Duke University teaching activities.

Boat Type	Name	Charges
62 ft. steel New England trawler	<i>John de Wolf II</i>	to be arranged
55 ft. trawler	<i>Beveridge*</i>	\$26.00 per hour
39 ft. cabin diesel powered	<i>Venus*</i>	\$18.00 per hour
17.5 ft. speedboat	<i>Thunderbird</i>	\$14.00 per hour \$112.00 per day
22.1 ft. open boat	<i>Ocypode</i>	\$14.00 per hour \$112.00 per day
Boston Whaier		\$6.00 per hour \$48.00 per day
Skiffs with outboard motors		\$3.50 per hour \$25.00 per day

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\*Crew required for safety of user and vessel.

These rates are intended to defray partially the cost of operating and maintaining these boats.

Most of these boats may be scheduled by visiting researchers through the Maintenance Office; however, first priority must be given to classes when they are in session during the spring and summer terms.



**Crew Overtime.** If crew overtime is involved before or after their normal work day and any time Saturday or Sunday, the following charges will apply from July 1, 1976 to June 30, 1977: Master, \$7.10 per hour; Winch Operator, \$5.85 per hour. An additional \$3 per man per hour will be charged for overtime on Duke University holidays.

**Research Space.** Research space, including seawater tables, is available on a limited basis for Duke University Marine Laboratory visitors. Research space rent for all users is \$1 per square foot. Typical size of laboratory-office area is 100 square feet. Requests for laboratory space, office space and/or seawater tables should be sent to the Business Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

**Teaching Space.** Various size classrooms are available from September through April of each year. Requests for these teaching areas, including class needs such as seawater tables, collecting equipment, etc., should be sent to the Business Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

**Check Cashing.** The banks in the Morehead City-Beaufort area have indicated that they will not cash personal checks for students unless they are guaranteed. Therefore, it is recommended that students who come to the Laboratory bring with them sufficient traveler's checks, money orders, certified checks, or cash to cover expenses.

## Financial Assistance

**Teaching Assistantships.** Five graduate student teaching assistantships are available during the period from January 1 through August 31 of each year. Students registered in a graduate program in any department in the sciences at Duke University may apply. Recipients must be in residence at Beaufort during the period of their appointment and also conduct, or plan to conduct, their research at the Duke University Marine Laboratory in Beaufort.

Applications must be received by the Director of Graduate Student Affairs before October 1. Applicants will be judged on the basis of need, qualifications for the courses in which they will assist, and previous teaching and graduate experience. A student may receive a maximum of three years' support under this program.

For further information, write the Director of Graduate Student Affairs, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

# Admissions







## Requirements and Procedures

All students applying to the Duke Marine Laboratory should complete the appropriate application form at the back of this *Bulletin* and submit a transcript of their grades. Applicants will be considered without regard to race, color, religion, sex, or national origin. Students desiring a transfer of credit to their home institutions should request a course approval form for transfer of credit from the Director, Duke University Marine Laboratory, Beaufort, North Carolina 28516.

**Summer Terms.** Introductory (100-level) courses offered at the Laboratory during the summer are intended for undergraduate students from the sophomore to the senior level. All other courses (200-level) offered at the Laboratory during the summer are intended for graduate students and senior undergraduate students. Applications should be submitted to the Director of the Duke University Marine Laboratory as early as possible to allow for adequate processing time and to assure a space in the desired course. Late applicants will be admitted if space permits. After acceptance, payment of deposit is essential to ensure reservation in a course.

Students wishing to apply summer credits toward an advanced degree at Duke University must, in addition to filling in the application blank, register with the Duke University Graduate School. Students who have had adequate preparation and approval of their major professor may request space for independent or thesis research.

Students should plan to arrive no sooner than Monday, May 9 for Term I; Sunday, June 12 for Term II; and Sunday, July 17 for Term III. All students, except those enrolled in the following term, should vacate dorm rooms on the last day of the term.

For a schedule of concurrent summer courses taught at the University of North Carolina Institute of Marine Sciences in Morehead City, N. C., write: Director, Marine Sciences Program, University of North Carolina, 12-5 Venable Hall, Chapel Hill, N. C. 27514.

**Spring Semester.** An interdisciplinary program in the marine sciences is offered at the Duke Marine Laboratory for the spring semester. The program is open to qualified juniors and seniors from Duke and other colleges and universities. The full semester program for each student consists of two courses, one or two seminars, and independent study. Applications are to be submitted by October 8 to the Director of the Duke University Marine Laboratory. Each applicant is required to submit two letters of recommendation, one of which must be from the director of undergraduate studies, or the equivalent, from the student's major department, and a current academic transcript. Students will be notified of the action of the Admission Committee prior to registration for the spring semester.

Duke University students are given preference in admission if judged equal to other applicants in academic preparation and general potential for making maximum use of the opportunities afforded by residence at the Laboratory. (The application form is in the back of this *Bulletin*.)

# Courses of Instruction





## FIRST SUMMER TERM

May 10—June 11, 1977

**Independent Study.** (Botany, Geology, or Zoology 191T.) For senior and junior majors with permission of the appropriate director of undergraduate studies and the supervising instructor. Course credit to be arranged. *Staff*

**Introduction to Biological Oceanography.** (Zoology 114L.) Physical, chemical, and biological processes that characterize the oceans, emphasizing special adaptations of organisms for life in the sea and factors controlling distribution and abundance of organisms. Not open to students who have had Geology 53 or Botany 53. Prerequisite: college biology. One and one-half courses. *Staff*

**Invertebrate Zoology.** (Zoology 175L.) Free-living and parasitic invertebrates. Lectures, readings, and laboratories: field trips to estuarine and marine habitats. Not open to students who have had Zoology 173, 174, or 274. Prerequisite: Introductory Biology. One and one-half courses. *Staff*

**Introduction to Marine Geology.** (Geology 168.) A study of elementary geological principles relating to the modern oceans. The course will emphasize field observations of beach and estuarine processes and the study of the historical development of the ocean basins. Prerequisite: introductory geology course or permission of the instructor. One and one-half courses. *Goll*

**Research.** (Zoology 353.) Hours to be arranged. Prior approval of instructor at the Duke University Marine Laboratory required. (For graduate students only.) *Staff*

## SECOND SUMMER TERM

June 13-July 15, 1977

**Independent Study.** (Botany, Geology, or Zoology 192T.) For senior and junior majors with permission of the appropriate director of undergraduate studies and the supervising instructor. Course credit to be arranged. *Staff*

**Marine Ecology.** (Zoology 203L.) The application of ecological theory to marine systems. The mathematical properties of population growth and species interactions; field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current literature. Prerequisites: a course in general zoology or invertebrate zoology and calculus. Knowledge of statistics helpful. One and one-half courses (6 graduate units). *Sutherland*

**Physiological Ecology of Marine Animals.** (Zoology 250.) A study of the physiology of marine and estuarine animals in relation to certain environmental factors (temperature, salinity, oxygen, and light). Animals representing numerous phyla from various habitats are studied. Prerequisite: a course in physiology and general zoology. One and one-half courses (6 graduate units). *Forward*

**Chemical Oceanography.** (Chemistry 240.) Distribution, alteration, and transport of chemical species in the marine environment. *R/V Eastward* cruise to gather samples for evaluating chemical processes in the ocean. Prerequisite: permission of instructor. A knowledge of physical chemistry is desirable. Includes lectures, laboratory work, and field trips. One and one-half courses (6 graduate units). *Baier*

**Marine Phycology.** (Botany 211.) An introduction to marine algae—their identification, taxonomy, morphology, physiology, and ecology. Field trips are complemented by laboratory study, culturing, and preparation of herbarium material. One and one-half courses (6 graduate units). *Searles*

**Marine Electrobiolgy.** (Biomedical Engineering 252.) This course deals with the physiology and behavioral consequences of bioelectric activity ranging from the cell membrane to the inter-animal communication level. Particular emphasis is placed on electrophysiological studies of marine organisms (vertebrate and invertebrate) wherein cellular correlates of animal behavior are clearly seen. Topics include: the ionic basis of bioelectric signals, the transmission of signals within and between excitable cells (nerve and muscle), the translation of neural signals into behavior patterns, the effects of externally applied electric fields on behavior (e.g., electroreception in fish), bioelectric "navigation" (in fish), and technical applications (such as electrofishing). One and one-half courses (6 graduate units). *Wachtel and Wolbarsht*

**Introduction to Mathematical Models in Biology.** (Zoology 211.) Rationale for mathematical models in biology. Adaptation of physical laws to the description of biological phenomena. Models of biological growth: the allometric equation; the implications of isomorphic growth. Biological processes as a function of time: elementary kinetics; the single process law. Statistical considerations in the estimation of parameters of biological models: error structures; tests of model adequacy. Prerequisites: One year of college mathematics and one course in statistical methods or permission of the instructor. One and one-half courses (6 graduate units). *Monroe*

**Comparative and Evolutionary Biochemistry.** (Biochemistry 276.) Lectures and discussion of the origin of life, evolution of the genetic code, mutation and protein polymorphism, natural selection and protein structure, and comparison of homologous proteins and nucleic acids. Laboratory work involves the purification and characterization of homologous proteins from fish and invertebrates. Techniques used include salt fractionation, electrophoresis, ion-exchange and molecular exclusion chromatography, fingerprinting, molecular weight determination, amino acid composition, and other related approaches. Prerequisite: consent of the instructor. One and one-half courses (6 graduate units). *Sullivan*

**Geological Oceanography.** (Geology 205.) Broad geological aspects of the ocean basins including origin, bottom physiography, sediment distribution, submarine sedimentary processes and shoreline processes. Field observations. Sampling procedures. Not open to students who have completed Geology 206. One and one-half courses (6 graduate units). *Pilkey and Glaeser*

**Research.** (Zoology 354.) Hours to be arranged. Prior approval of instructor at the Duke University Marine Laboratory required. (For graduate students only.) *Staff*

### THIRD SUMMER TERM

July 18-August 19, 1977

**Independent Study.** (Botany, Geology, or Zoology 191T.) For senior and



junior majors with permission of the appropriate director of undergraduate studies and the supervising instructor. Course credit to be arranged. *Staff*

**Invertebrate Embryology.** (Zoology 278.) Lectures, readings, and laboratory work dealing with rearing, development, and life history of invertebrates. Prerequisite: consent of the instructor. One and one-half courses (6 graduate units). *McClay*

**Membrane Physiology and Osmoregulation.** (Physiology 212.) Physiology of marine and estuarine organisms, with emphasis on cellular transport processes and electrophysiology. The course also includes the functions, mechanisms, and comparative aspects of ionic and osmotic regulation in plants and animals. Laboratory work deals with membrane transport processes in single cells and epithelia, basic electrophysiology, permeability properties of synthetic membranes, renal and gill transport processes in fish and crustaceans, and the applications of radiotracer and other physical and chemical techniques to the study of membrane function. Prerequisite: permission of instructor. One and one-half courses (6 graduate units). *Gutknecht*

**Comparative and Evolutionary Biochemistry.** (Biochemistry 276.) Lectures and discussion of the origin of life, evolution of the genetic code, mutation and protein polymorphism, natural selection and protein structure, and comparison of homologous proteins and nucleic acids. Laboratory work involves the purification and characterization of homologous proteins from fish and invertebrates. Techniques used include salt fractionation, electrophoresis, ion-exchange and molecular exclusion chromatography, fingerprinting, molecular weight determination, amino acid composition, and other related approaches. Prerequisite: consent of the instructor. One and one-half courses (6 graduate units). *Sullivan*

**Biological Oceanography.** (Zoology 214L.) The impact of biological processes on the physical and chemical character of the environment and the regulating role of abiotic processes on organic productivity are examined. The factors regulating primary and secondary productivity are studied using as examples the estuary and ocean adjacent to Beaufort. Emphasis is on the design and execution of directed research rather than lectures. Prerequisite: permission of instructor. Introductory Biological or Chemical Oceanography recommended. One and one-half courses (6 graduate units). *Barber*

**Marine Invertebrate Zoology.** (Zoology 274L.) Structures, functions, and habits of invertebrate animals under natural and experimental conditions. Field trips included. Not open to undergraduate students who have had Zoology 175 except with permission of the director of undergraduate studies. Prerequisite: introductory biology. One and one-half courses (6 graduate units). *Barnes (visiting summer faculty)*

**Environmental Oceanography.** (Chemistry 230.) Examination of chemical, biological, and geological aspects of pollution in the marine environment. The interaction of man with natural marine processes on shore lines and shelves. Application of marine science to compatible utilization of marine resources. Prerequisite: permission of instructor. A knowledge of physical chemistry is desirable. One and one-half courses (6 graduate units). *Baier and Staff*

**Introduction to Marine Geophysics.** (Geology 250.) Topics include seismic reflection and refraction, magnetics, gravity, and seismology. Prerequisite: Introductory physics or consent of instructor. One and one-half courses. *Rosendahl*

**Research.** (Zoology 353.) Hours to be arranged. Prior approval of instructor at the Duke University Marine Laboratory is required. (For graduate students only.)



## Spring Semester—Undergraduate Program

January 10-April 29, 1977

The semester program consists of the courses listed below. A student may apply during the spring to continue study at the Marine Laboratory during the summer either by participating in senior-graduate courses or by continuing the independent studies initiated during the spring term.

**Homo Sapiens and the Marine Environment.** (Interdisciplinary Course 104.) Economic, legal, medical, political, social, and scientific viewpoints on the extent to which modern society has affected the marine environment, with special emphasis on problems of coastal North Carolina. Lectures and laboratories. Prerequisite: consent of instructor and director of undergraduate studies of student's major department. One course. *Costlow and Staff*

**Adaptations of Organisms to the Marine Environment.** (Biochemistry 220.) An introduction to basic concepts of biochemistry and to variables in the marine environment which evoke adaptive responses. Specific adaptations at the molecular level are considered and the general topic of biological fitness is discussed from a biochemical viewpoint. Laboratory experiments utilize many basic methods of biochemical analysis. The course is designed to stimulate interest in the molecular basis of adaptation and to give participants greater insight into the unsolved problems in this area. Prerequisites: basic biology and chemistry and consent of instructors. One course. *C. Bonaventura and J. Bonaventura*

**The Marine Environment.** (Botany, Geology, or Zoology 169.) The interrelationships of the geological, chemical, and biological aspects of the estuarine and oceanic environments. Lectures and laboratories. Prerequisite: introductory chemistry and consent of instructor and the appropriate director of undergraduate studies. One course. *Sutherland*

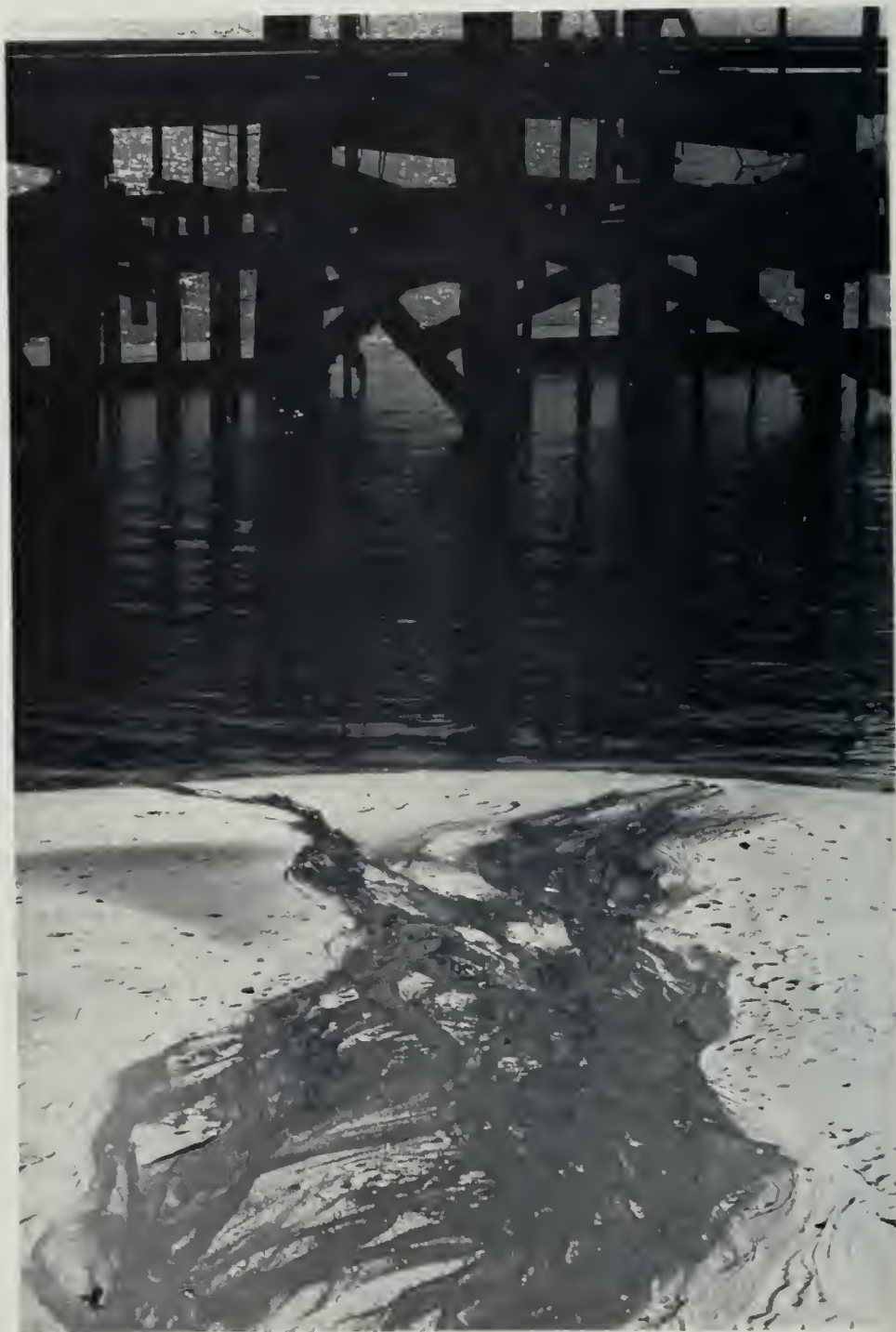
**Physiology of Marine Organisms.** (Zoology 150L.) Comparative physiology of marine animals including special ecological and behavioral adaptations. Lectures and laboratories. A student may not receive credit for both Zoology 150L and 250L. Prerequisite: introductory biology and chemistry; consent of instructor and director of undergraduate studies of student's major department. One course. *Forward*

**Seminar.** (Zoology 296S.) Recent research in the biochemistry and genetics of marine organisms: enzymes, evolution, and ecological strategies. Half-course. *Sullivan.* (Zoology 296S.) Man's impact on biogeochemical cycles. Half-course. *Barber and Baier.* Additional seminars may be introduced to accommodate staff and student interests.

**Independent Study.** (Botany, Geology, or Zoology 192.) For senior and junior majors with permission of the director of undergraduate studies and the supervising instructor. One and one-half courses. *Staff*



# Seminars







## Seminars, Academic Year 1975-1976

Date	Speaker	Topic
Nov. 18	Dr. W. A. Dunson Department of Biology College of Science The Pennsylvania State University University Park, Pennsylvania	Diving for Sea Snakes in the Timor and Visayan Seas
Jan. 15	Dr. David Evans Department of Biology University of Miami Coral Gables, Florida	The Occurrence of the Fresh Water Pump (Sodium- Hydrogen Ion Exchange) in Marine Teleosts
Jan. 19	Thomas Eure, Chairman North Carolina Coastal Resources Commission Morehead City, North Carolina	North Carolina Coastal Area Management Act of 1974
Jan. 23	Mr. Jerry Hardesty Planning Commission Currituck, North Carolina	Planning and Implementation in Currituck County
Jan. 29	Dr. T. W. Johnson Department of Botany Duke University Durham, North Carolina	Seeing the Flowers from Horseback
Jan. 30	Dr. Caroline Pond Division of Biological Sciences University of Michigan Ann Arbor, Michigan	The Significance of Lactation in the Evolution of Mammals
Feb. 3	Dr. S. M. Haq Institute of Marine Biology University of Karachi Karachi, Pakistan	Marine Sciences in Pakistan
Feb. 6	Dr. Frederick Nijhout Laboratory of Parasitic Diseases National Institutes of Health Bethesda, Maryland	Control of Molting and Metamorphosis in the Tobacco Horn Worm

Feb. 25	Dr. Frans Jobsis Department of Physiology and Pharmacology Duke University Medical Center Durham, North Carolina	Why Oxygen?
Feb. 27	Dr. Clay A. Sassaman Woods Hole Oceanographic Institution Woods Hole, Massachusetts	Dynamics of a Lactate Dehydrogenase Polymorphism in the Woodlouse <i>Porcellio scaber</i> Latreille
March 23	Dr. John F. Farrington Woods Hole Oceanographic Institution Woods Hole, Massachusetts	Hydrocarbons and the Surface Sediments of the Western North Atlantic
March 24	Dr. Paul Godfrey Department of Botany University of Massachusetts Amherst, Massachusetts	Ecological Consequences of Barrier Island Migration
April 8	Professor C. L. Prosser Department of Physics and Biophysics University of Illinois Champaign-Urbana, Illinois	Cellular Mechanisms of Temperature Adaptation
April 12	Mr. Timothy Cowles Department of Zoology Duke University Durham, North Carolina	Impressions of Russian Marine Facilities
April 14	Dr. Gary Weekman School of Agriculture North Carolina State University Raleigh, North Carolina	Pesticides and the Estuarine Environment
April 14	Dr. John Vernberg Baruch Institute of Coastal Research University of South Carolina Columbia, South Carolina	Physiological Ecology of Marine Animals
April 21	Dr. Orrin H. Pilkey Department of Geology Duke University Durham, North Carolina	A Geologist Looks at Development on the Outer Banks
May 3	Dr. Knut Schmidt-Nielsen Department of Zoology Duke University Durham, North Carolina	The Importance of Body Size
May 13	Dr. Bruce Robison Marine Sciences Institute University of California Santa Barbara, California	Biological Studies During the <i>Alpha Helix</i> Expedition to Southeast Asia



May 21	Dr. Irwin Fridovich Department of Biochemistry Duke University Medical Center Durham, North Carolina	How to Get Along with Oxygen
May 24	Dr. Peter Wiebe Woods Hole Oceanographic Institution Woods Hole, Massachusetts	Sampling Variability and Spatial Heterogeneity in the Marine Environment
May 26	Dr. Ruth Turner Museum of Comparative Zoology Harvard University Cambridge, Massachusetts	Bivalve Larvae—Behavior Distribution and Identification
May 27	Dr. Thomas Malone Lamont-Doherty Geological Observatory Palisades, New York	Sewage Disposal in Estuaries and the Problem of Effluent Mariculture
June 4	Dr. Richard Cooper National Marine Fisheries Service Woods Hole, Massachusetts	<i>In situ</i> Studies on the Geology and Ecology of Georgia's Bank Submarine Canyons
June 9	Dr. Bruce Rosendahl Scripps Institution of Oceanography La Jolla, California	Crustal Genesis of the Eastern Pacific
June 23	Dr. George Somero Department of Marine Biology Scripps Institution of Oceanography La Jolla, California	Macro and Micromolecules as Partners in Molecular Adaptation

July 1	Dr. Arthur W. Martin Department of Zoology University of Washington Seattle, Washington	Life and Death of <i>Nautilus macromphalus</i> with Particular Inquiry into Reproduction, Circulation, and Excretion
July 12	Dr. I. M. Klotz Department of Molecular Biology Northwestern University Evanston, Illinois	Structure and Function of Hemerythrin: An Alternative Oxygen Carrier
July 21	Dr. David R. McClay Department of Zoology Duke University Durham, North Carolina	Embryonic Cell-Cell Interactions: Molecular Approaches
August 4	Dr. Robert Barnes Department of Biology Gettysburg College Gettysburg, Pennsylvania	Adaptive Radiation in Anomuran Crustaceans
Aug. 9	Dr. John Gutknecht Duke University Marine Laboratory Beaufort, North Carolina	Ion Transport and Osmotic Regulation in Plant and Animal Cells
Aug. 12	Dr. Gregory Whitt Provisional Department of Genetics and Development University of Illinois Urbana, Illinois	Evolution of the Lactate Dehydrogenase Isozymes

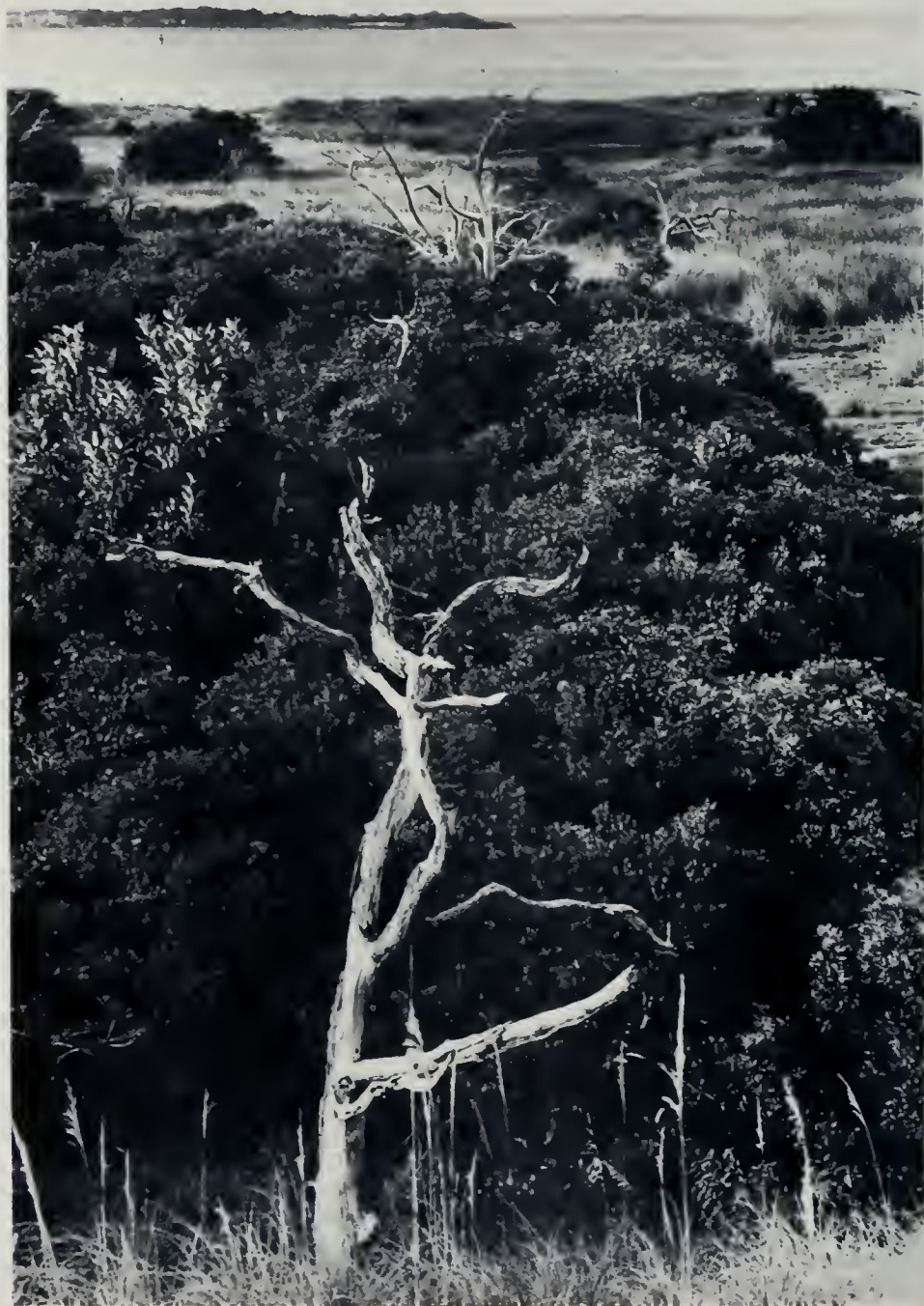




Graduate Student Seminars, Academic Year 1975-1976

Aug. 28	Mr. Daniel Rubenstein Department of Zoology Duke University Durham, North Carolina	The Social Behavior and Ecology of the Horses of Shackleford Banks
Sept. 15	Mr. John Commito Department of Zoology Duke University Durham, North Carolina	Competition, Predation, and the Structure of Soft-Bottom Communities
Sept. 22	Mr. Timothy Cowles Department of Zoology Duke University Durham, North Carolina	Variation in Grazing Rate and Resource Utilization Among Pelagic Herbivores: A Research Proposal
Sept. 29	Ms. Mary Bisson Department of Botany Duke University Durham, North Carolina	Turgor Regulation in a Euryhaline Marine Alga, <i>Codium decorticans</i>
Oct. 6	Dr. Thomas Fisher Department of Zoology Duke University Durham, North Carolina	The Growth and Allometry of the Solitary Tunicate, <i>Styela plicata</i>
Oct. 13	Mr. Lloyd Petrie Department of Chemistry Duke University Durham, North Carolina	Irreversible Pb(II) Transport During Anodic Stripping Voltammetry
Oct. 27	Mr. Walker Smith Department of Botany Duke University Durham, North Carolina	The Role of Phytoplankton Excretion and Heterotrophic Production in the Carbon Flux in an Upwelling Region
Dec. 15	Mr. Walter Nelson Department of Zoology Duke University Durham, North Carolina	Population Dynamics of Eelgrass Amphipods
Dec. 19	Mr. Thomas Cronin Department of Zoology Duke University Durham, North Carolina	Factors Contributing to Vertical Migration and Horizontal Transport in Larvae
Jan. 19	Ms. Martha Farmer Department of Physiology and Pharmacology Duke University Durham, North Carolina	The Interaction of Carbon Dioxide with Hemoglobin

# Publications





## Publications 1975-1976

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# Appendix





## CALENDAR FOR SUMMER SESSION

Term I begins—May 10  
Term II begins—June 13  
Term III begins—July 18

Term I ends—June 11  
Term II ends—July 15  
Term III ends—August 19

## ADMINISTRATION AND LABORATORY PERSONNEL

### Advisory Committee

John D. Costlow, Ph.D., *Director*  
Duke University Marine Laboratory

Donald J. Fluke, Ph.D., *Chairman*  
Department of Zoology

John W. Gutknecht, Ph.D.  
Department of Physiology and Pharmacology

R. L. Hill, Ph.D., *Chairman*  
Department of Biochemistry

Sigfred L. Linderoth, Jr., M.S.  
Department of Mechanical Engineering

Orrin H. Pilkey, Ph.D.  
Department of Geology

Louis Quin, Ph.D.  
Department of Chemistry

Richard B. Searles, Ph.D.  
Department of Botany

### Academic Staff

Rodger Baier, Ph.D.  
Chemical oceanography

Richard T. Barber, Ph.D.  
Biological oceanography

\*Robert D. Barnes, Ph.D.  
Marine invertebrate zoology

\*Stephen A. Bloom, Ph.D.  
Marine ecology

Celia Bonaventura, Ph.D.  
Protein structure and function

Joseph Bonaventura, Ph.D.  
Protein structure and function

C. G. Bookhout, Ph.D.  
Marine invertebrate embryology and invertebrate zoology

John D. Costlow, Ph.D.  
Marine invertebrate embryology and experimental zoology

Richard B. Forward, Ph.D.  
Physiological ecology of marine animals

Robert M. Goll, Ph.D.  
Distribution of living radiolaria

I. E. Gray, Ph.D., Professor Emeritus  
Marine ecology and entomology

John Gutknecht, Ph.D.  
Membrane physiology

William Kirby-Smith, Ph.D.  
Marine ecology

\*Orrin H. Pilkey, Ph.D.  
Geological oceanography

\*Bruce Rosendahl, Ph.D.  
Plate tectonics

\*Richard B. Searles, Ph.D.  
Marine phycology

J. Bolling Sullivan, Ph.D.  
Comparative and evolutionary biochemistry

John P. Sutherland, Ph.D.  
Marine ecology

Howard Wachtel, Ph.D.  
Biomedical engineering

Adam Zsolnay, Ph.D.  
Trace organic material in the marine environment

\*Summer only.

## Administrative Staff

### Director

John D. Costlow  
Professor of Zoology

### Director of Cooperative Program in Biological Oceanography—Coordinator, Coastal Upwelling Ecosystems Analysis

Richard T. Barber  
Associate Professor of Zoology and Botany

### Director of Graduate Student Affairs

Richard B. Forward  
Assistant Professor of Zoology

### Director of Undergraduate Student Affairs

Rodger W. Baier  
Assistant Professor of Chemistry

### Business Manager

Michael P. Bradley

### Maintenance Supervisor

Norris A. Hill

### Housekeeping Supervisor

Olive C. Godette

### Marine Superintendent of Oceanographic Operations

Eric B. Nelson

### Administrative Assistant, Coastal Upwelling Ecosystems Analysis

Linda J. Allred

### Master of R/V EASTWARD

Ragnvald Sandoy

## Resident Researchers

Dr. Rodger Baier—trace metal speciation and transport in coastal waters entailing sampling of sediment and water in rivers, in estuaries, on the slope, and over the continental rise; methods research to interpreting results from anodic stripping voltammetry using synthetic model solutions and samples with varying content of organic matter

Dr. Richard T. Barber—effect of chemical properties of seawater on primary production, (major and minor constituents, trace elements, dissolved gases, the carbon dioxide system, dissolved organic constituents), the nutrient systems and their biochemical and physiochemical aspects, and dynamic equilibria in the chemical systems of the marine environment; also emphasis on large scale oceanic upwelling systems and on upper estuary (fresh water/salt water interfaces)

Dr. Celia Bonaventura—molecular controls of hemoglobin function; comparative studies using respiratory proteins from marine organisms to illustrate aspects of biochemical adaptation

Dr. Joseph Bonaventura—the structure-function relationships in protein molecules, particularly those involved in transporting oxygen (hemoglobins, hemerythrins and hemocyanins); much effort devoted to understanding the molecular basis of adaptation in marine organisms; Sick cell hemoglobin and other abnormal human hemoglobins and searching for chemical means of increasing oxygen delivery to tissues by altering intraerythrocytic oxygen affinity

Dr. C. G. Bookhout—effects of insecticides on the complete development of mud-crabs and blue crabs; study of the development of the family of crabs to which the blue crab belongs

Dr. Marius Brauer—characterization of the intermediates found in the assembly of the 48-subunit aggregate of *Limulus* hemocyanin by means of ultracentrifugation, oxygen equilibria, and kinetics

Dr. John Costlow—the development of endocrine mechanisms in marine invertebrate larvae, the transitional phases during metamorphosis, and the relationship between endocrine mechanisms found in different marine animals; structure and habits study of living invertebrates, as well as their behavior under experimental conditions; ecology, physiology, and systematics of major constituents of zooplankton including vertical migration, seasonal variations, and zoogeography of zooplankton, as well as the embryological and larval processes in marine invertebrates, culture of marine invertebrates under controlled environmental conditions, physiology and biochemistry of invertebrate development

Dr. Richard Forward—photobiology studies of marine animals and dinoflagellates with emphasis on relating the basic physiology to the ecology of the organism

Dr. Stephen Garavelli—studies on the amino acid sequence of trout hemoglobin, computer representation of protein structures

Dr. Robert Goll—evolutionary processes in marine microzooplankton; radiolaria, studied both biogeographically and paleontologically, are organisms of particular interest

Dr. I. E. Gray—preparation of atlas of marine benthic organisms

Dr. John Gutknecht—mechanisms and functions of ion transport across cell membranes working with giant algae cells, fish, and synthetic phospholipid bilayer membranes



Dr. Susan Huntsman—phytoplankton nutrition and organometallic complexes in the sea

Dr. William Kirby-Smith—effects of thermal additions on the development of fouling communities; studies on the water quality ramifications on estuaries of converting bordering forests to agricultural uses; biological problems involved in suspension feeding aquaculture systems with emphasis on the feeding physiology of bay scallops

Dr. George Lapenas—investigations of compounds which irreversibly alter the oxygen affinity of intraerythrocytic hemoglobin; studies on the secretion of gases into fish swimbladders

Ms. Jane Kogelschatz—Coastal Upwelling Ecosystems Analysis Program; Primary Productivity studies; program logistics

Dr. Emilia Pandolfelli—studies on the effect of steady-state light perturbation of carbon monoxide-hemoglobin complexes in order to assess the role of various kinetic parameters in the normal functional properties of hemoglobin

Dr. J. Bolling Sullivan—biochemical studies of the evolutionary process emphasizing the role of proteins as indicators of evolutionary events

Dr. John Sutherland—research on a variety of benthic marine communities involving the experimental analysis of the processes of competition and predation and their effect on community structure

Dr. Brigitte Volkmann—systematics and speciation in the genus *Tisbe* (Copepoda, Harpacticoida)

Dr. Yoshio Yamamichi—embryology of marine invertebrates

Dr. Adam Zsolnay—transfer of organics by colloidal material in the sea; phytoplankton exudates and their bacterial transformation



## Visiting Researchers

Robert Barnes, Ph.D.  
Department of Biology  
Gettysburg College  
Gettysburg, Pennsylvania  
Invertebrate zoology.

Maurizio Brunori, Ph.D.  
Istituto di Chimica Biologica  
Centro di Biologia Molecolare  
Citta Universitaria  
Rome, Italy  
Studies of hemoglobins, hemocyanins, and cytochromes.

Marit Christiansen, Ph.D.  
University of Oslo  
Oslo, Norway  
Salinity and temperature effects on crab larvae, and effects of the larvicide ZR 515 on the development of crab larvae in various salinities and temperatures.

Genevieve Payen, Ph.D., CNRS  
Laboratoire d'Evolution de la Faculte des Sciences de Paris  
Paris, France  
Control of sexual differentiation in Crustacea.

Orrin Pilkey, Ph.D.  
Department of Geology  
Duke University  
Sedimentation on the northern Hatteras and Hispaniola abyssal plains; Mapping of individual turbidity current flows.

Bruce Rosendahl  
Scripps Institute of Oceanography  
La Jolla, California  
Plate tectonics.

Frank Schatzlein, Ph.D.  
California State University  
Long Beach, California  
Acclimation of the oxygen consumption of crab larvae to temperature.

Richard B. Searles, Ph.D.  
Department of Botany  
Duke University  
Study of the benthic communities on the continental shelf using facilities of R/V *Eastward*; and a descriptive study of the epiphytic algae which grow in the sounds on the blades of eelgrass and other marine angiosperms.

Nora Terwilliger, Ph.D.  
Oregon Institute of Marine Biology  
University of Oregon  
Charleston, Oregon  
Studies of invertebrate respiratory proteins.

Robert Terwilliger, Ph.D.  
Oregon Institute of Marine Biology  
University of Oregon  
Charleston, Oregon  
Studies of invertebrate respiratory proteins.

Howard Wachtel, Ph.D.  
Department of Biomedical Engineering  
Duke University  
Marine electrobiology.

Michael T. Wilson, Ph.D.  
Department of Biochemistry  
University of Essex  
Colchester, England  
Characterization of fish cytochrome oxidase.

## GRADUATE STUDENTS ENGAGED IN THESIS RESEARCH

Sandra Allison, B.Sc.  
Department of Physiology and Pharmacology  
Duke University  
Water permeability of membranes.

Mary Bisson, B.A.  
Department of Botany  
Duke University  
Membrane physiology.

John Commito, B.A.  
Department of Zoology  
Duke University  
The regulation of estuarine soft bottom community structure.

Timothy Cowles, M.A.  
Department of Zoology  
Duke University  
Feeding interactions among zooplankters.

Thomas Cronin, M.A.  
Department of Zoology  
Duke University  
Photophysiology of planktonic Crustacea.

Martha Farmer, B.S.  
Department of Physiology and Pharmacology  
Duke University  
The interaction of carbon dioxide with certain marine respiratory pigments.

John Freeman, M.S.  
Department of Zoology  
Duke University  
Hormonal control of molting.

Jean Hamilton, B.S.  
Department of Geology  
Duke University  
Subsurface stratigraphy of Shackleford.

Duncan Howe, B.A.  
Department of Zoology  
Duke University  
Gill membrane transport in toadfish, *Opsanus tau*.

Burton Jones, B.S.  
Department of Zoology  
Duke University  
Modeling of phytoplankton growth in nutrient-rich unconditioned seawater.

Joseph Martin, B.S.  
Department of Zoology  
Duke University  
The functional significance of protein polymorphism in the oyster.

Walter Nelson, B.A.  
Department of Zoology  
Duke University  
Community dynamics of the epifauna of eelgrass beds.

Patricia Parsley, B.A.  
Department of Botany  
Duke University  
Phytoplankton community dynamics.

Lloyd Petrie, B.S.  
Department of Chemistry  
Duke University  
Voltammetric analysis of the chemical speciation of  $Pb^{+2}$  in seawater and speciation effects of  $Pb^{+2}$  transport in algae.

Raimund Röhl, B.S.  
Department of Chemistry  
Duke University  
Lead transport in sediments.

Laura Sarle, B.S.  
Department of Geology  
Duke University  
Identification and analysis of sediment storage areas of the Shackleford Banks beaches.

Walker Smith, B.S.  
Department of Botany  
Duke University  
Photosynthesis and phytoplankton primary productivity; phytoplankton excretion.

Jay Van Tassell, B.S.  
Department of Geology  
Duke University  
Sediment movement on Shackleford Banks and Bird Shoals—Continental rise bathymetry.

Terry L. West, M.S.  
Department of Zoology  
Duke University  
Settlement and metamorphosis in polychaetes.



## R/V EASTWARD Personnel

Susan Barker, Seaman  
Billy Corey, Seaman  
James Davis, Shore Engineer  
Clyde R. Everett, Messman/Cook  
Robert Gray, Electrician  
James Jones, Seaman  
Edwin Lewis, Wiper  
Preston Mason, Second Mate  
James Meyer, Oceanographic Party Chief  
Curtis Nelson, Chief Engineer

George Newton, Oceanographic Party Chief  
Curtis Oden, Bosun/Deck Engineer  
James Robinson, Oiler  
Roger Shepherd, Coordinator, Oceanographic Services  
Benjamin Smith, Cook  
Harold Willis, First Assistant Engineer  
Howard Wilson, Steward/Cook  
Harold Yeomans, Chief Mate





### Research Technicians

Elaine Barber, B.A.	Giulia Ferruzzi, M.S.	Penny Hooper, B.S.
Lesley Barling, M.S.	Connie Frohlichstein, B.A.	Jackie Paul, B.S.
Shirley Bourne, M.A.	Lucretia Garrigan, M.S.	Louise Pennell, B.S.
William Bretz, Ph.D.	Gerald Godette, B.S.	Rebecca Piver, B.S.
Roselind Cronin	Teri Lynn Herbert, M.S.	William Robinson, B.S.
Clarke Edwards, M.S.	Sally Herring	Patrick Whaling

### Clerical Staff

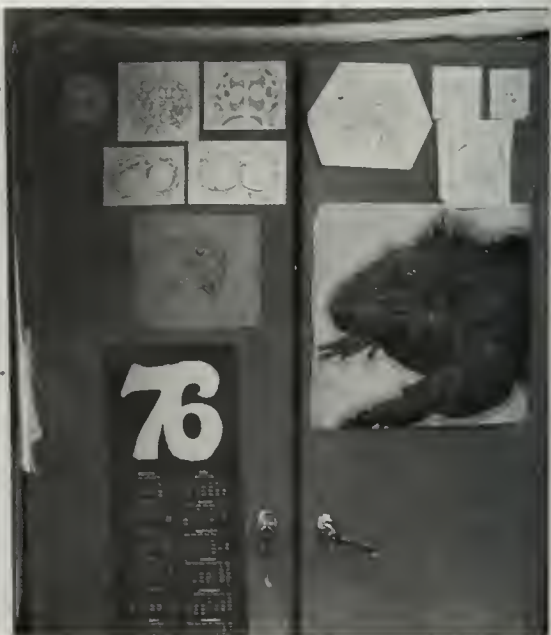
Cindy Fowler, Staff Assistant	Vera Jordan, Clerk Typist
Dianne Gagnon, Accounting Specialist	Lilian Lorenzsonn, Secretary
Linda Horne, Clerk Typist	Estelle Merrell, Administrative Secretary
Dorothy Johnson, Administrative Secretary	Sylvia Springle, Administrative Secretary
Ellen Jones, Secretary	Mamre Wilson, Secretary

### Technical Support Staff

David Bunting, Senior Draftsman	Irvin Moore, Carpenter
James Chadwick, Light Equipment Operator	Tommy Morton, Head Cook
Claudia Davis, Housekeeper	Sylvester Murray, Food Service Aide
Clifton Davis, Senior Plumber	George Robinson, Painter
Helen Davis, Housekeeper	Sophia Turnage, Junior Buyer
Annie Fulford, Housekeeper	Mildred Tyre, Housekeeper
Catherine Gibbs, Housekeeper	Jean Williams, Senior Library Assistant
Phillip Golden, Plumber	James Willis, Boat Serviceman/Operator
Horace Holland, Mechanic	
William Hunnings, Senior Electronics Technician	

### Policy of Nondiscrimination

Duke University does not discriminate on the basis of race, color, national and ethnic origin, or sex, in the administration of educational policies, admission policies, financial aid, employment, or any other university program or activity. It admits qualified students of any race, color, national and ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students.



APPLICATION FOR ENROLLMENT IN THE DUKE UNIVERSITY MARINE LABORATORY  
SUMMER SESSION

Please type or use black ink.

Date .....

Name .....  
Last First Middle

Date of Birth: Month ..... Day ..... Year .....

Social Security No. ....

Reserve a place for me in the following course(s): (Only one 6-unit course per term will be permitted;  
first and second choice should be indicated.) EACH APPLICANT IS REQUIRED TO SUBMIT A  
TRANSCRIPT OF GRADES TO THE DIRECTOR.

FIRST TERM:

Course Number	Title of Course
.....	.....
.....	.....

SECOND TERM:

Course Number	Title of Course
.....	.....
.....	.....

THIRD TERM:

Course Number	Title of Course
.....	.....
.....	.....

Fees will be paid by: Self .....Other .....

Reserve a room: Term I .....Term II .....Term III .....

Attended Summer Sessions at Duke University Marine Laboratory: Yes .... No .....

Years .....

Request grade(s) be applied toward:	If college student, list:
Undergraduate credits .....	Undergraduate .....Year .....
Graduate credits .....	Graduate .....Year .....
General (unclassified) .....	

Name and address of school: .....  
.....

Are you a full-time teacher in an elementary or secondary school? .....

If so, list name and address of school: .....

.....

Male ..... Female ..... Married ..... Single .....

Colleges and/or universities attended and degrees: .....

.....

.....

Current address:

Street .....

Rural Route or P. O. Box .....

City.....State .....Zip .....

Area Code .....Telephone Number .....

Forwarding address:

Street .....

Rural Route or P. O. Box .....

City.....State .....Zip .....

Area Code.....Telephone Number .....

Mail to:

Director  
Duke University Marine Laboratory  
Beaufort, North Carolina 28516



APPLICATION FOR ENROLLMENT IN THE DUKE UNIVERSITY MARINE LABORATORY  
SPRING SEMESTER MARINE SCIENCES PROGRAM FOR UNDERGRADUATES

Please type or print.

Date .....

1. Name .....  
Last First Middle

2. Social Security Number ..... Sex: Male ..... Female .....

3. Date of Birth: Month ..... Day ..... Year .....

4. A. Current mailing address:  
Street or P. O. Box .....  
City ..... State ..... Zip .....  
Area Code ..... Telephone Number .....

B. Permanent or home address:  
Street or P. O. Box .....  
City ..... State ..... Zip .....  
Area Code ..... Telephone Number .....

5. A. Present marital status: Single ..... Married .....  
If applicable, give number of dependent children .....

B. Name and address of next of kin:  
Name ..... Relationship .....  
Street or P. O. Box .....  
City ..... State ..... Zip .....  
Area Code ..... Telephone Number .....

6. A. Duke University undergraduate student:  
Trinity College of Arts and Sciences .....  
Engineering .....

B. Special student desiring transfer credit:  
Name and address of home institution .....  
.....  
City ..... State ..... Zip .....

C. Major department ..... Class .....

7. The following persons have been requested to mail letters of recommendation to the Director of the Laboratory:

A. Name .....  
.....  
City ..... State ..... Zip .....  
Area Code ..... Telephone Number .....

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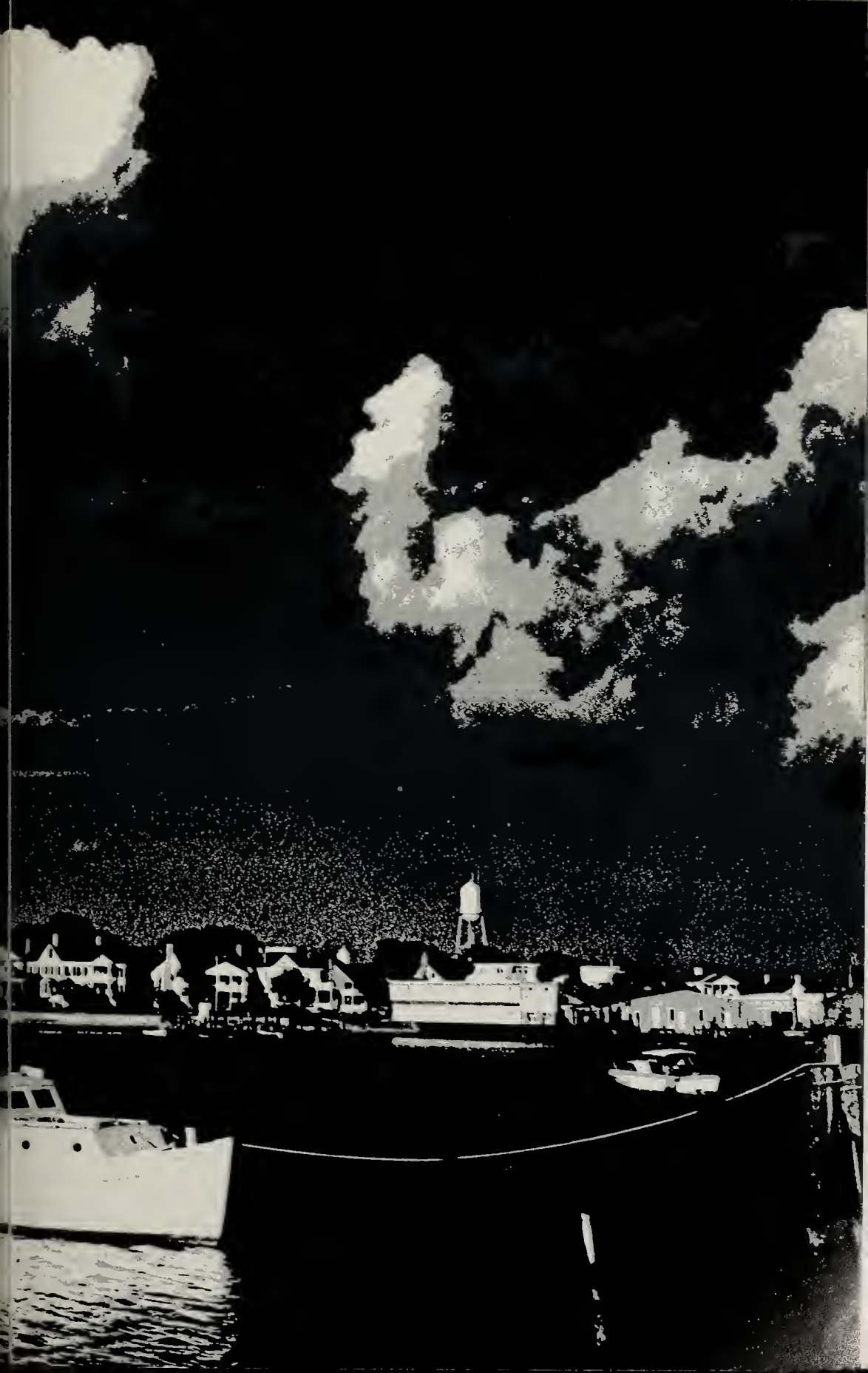
B. Name ..... Position .....  
.....  
City ..... State ..... Zip .....  
Area Code .....Telephone Number .....

8. Transcript(s) will be sent by the following institution(s):  
.....  
.....  
.....

9. Have you ever been placed on probation or suspended or dismissed from any school?

Yes .....No .....(If yes, please explain below.)

Mail application to: Director  
Duke University Marine Laboratory  
Beaufort, North Carolina 28516



Bulletin of Duke University Marine Laboratory Volume 49 November 1976 No. 2







# Bulletin of Duke University

The Graduate School

1977-1978

Durham, North Carolina 1977

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EDITORIAL ASSISTANT  
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Duke University Bulletins Office

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PHOTOGRAPHS  
Elizabeth Matheson

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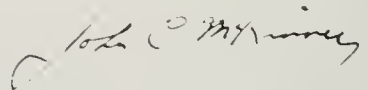
## To the Prospective Graduate Student at Duke University

Several years ago a committee of distinguished scholars was appointed and asked to appraise the state of graduate education at Duke University and indicate guidelines for its future development. I would like to quote briefly from the preamble of their report:

The primary role of a university is to provide a focus for the growth of ideas. Since ideas grow in the minds of men, communication between scholars, between faculty and students — in short, teaching — is the first basic function of a university. But without great ideas to communicate — ideas old and new, tradition and nascent — teaching is an exercise of futility. Therefore, the second basic function of a university must be research, characterized by the spirit of free inquiry and the exploration, analysis, and synthesis of ideas. These two faces of a university are complementary.

Even in the undergraduate college or in the professional school, the student learns best when moved by a spirit indistinguishable from the mood of the scholar engaged in original research. The ideas taught are, in fact, new to the student and therefore fit material for his "original" research. But it is in the graduate school that teaching and research become truly inseparable.

To the student in search of a superior graduate education, Duke University has much to offer: excellent research facilities such as an outstanding library, a major computing center, modern laboratories — but above all, a highly productive graduate faculty dedicated to the twin functions of teaching and research. The following pages, and the information they contain, are addressed to the student seeking a soundly based graduate education.



John C. McKinney  
Dean of the Graduate School

# University Administration

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\* On special leave of absence, effective January 20, 1977, to serve as U.S. Secretary of Commerce.

† Term expires September, 1977.







# Introduction

Writing in the 1920s the philosopher and man of science Alfred North Whitehead defined the purpose of a university in these terms: "The justification of a university is that it preserves the connection between knowledge and the zest for life, by uniting the young and the old in the imaginative consideration of learning." If this is true of a university generally, it is true of a graduate school especially. Faculty members and graduate students work together in the imaginative recasting of ideas necessary for successful research and the development of human knowledge.

Ideally, a graduate school is a community of scholars engaged in imparting and extending the realm of human knowledge in the arts and sciences. A select group of students is admitted each year to undergo the rigorous discipline of an advanced degree program, the successful among them to emerge as scholars of promise. To enter upon graduate education today is to accept a real challenge, but this decision should not be made casually. The work toward a doctorate requires several years of tireless effort and possible sacrifice, and the material rewards may be less certain than in some alternative endeavor. However, pursued with determination, graduate education can be the doorway to a stimulating, creative, and

meaningful life. The student who is contemplating this challenge may have many questions in mind; the material which follows is an attempt to answer some of them.

## The Decision to Go to Graduate School

The decision to work toward an advanced degree must be a personal commitment born of a willingness to devote oneself to many months or possibly years of academic discipline just at an age when one may be impatient for financial independence and freedom from academic discipline. Graduate education requires all the energy, enthusiasm, and self-discipline at one's disposal; to enter upon it half-heartedly is to invite discouragement or failure.

An equally important requisite for success in graduate study is the possession of a natural curiosity and the capacity for self-discipline. A good undergraduate record may or may not be adequate evidence of these characteristics. Many students with excellent undergraduate records have been unsuccessful in graduate study because their undergraduate training stressed an ability to marshal facts and to articulate these facts

rather than real understanding and analysis of material. On the other hand, many distinguished scholars had undistinguished undergraduate records. In gaining admission to a graduate school, the undergraduate record is, of course, an important element, but usually some margin is left to allow for students who develop serious academic interests late in their undergraduate careers. Students are often best able to judge for themselves whether or not their grades are a true gauge of their ability.

There is no unerring way of knowing in advance whether one will be successful or happy in graduate school. It is quite likely, however, that if one has both the motivation and ability and does not try it, there will be regrets in later years. Although the decision must be an individual choice, superior intellectual ability is a scarce human resource, and the encouragement and utilization of it is a matter of community as well as personal concern.

## Choosing a Graduate School

Over two hundred and fifty universities today offer work leading to the Ph.D. degree. Among these are about sixty institutions which grant only two or three such degrees a year in all fields combined. At the other end of the scale are about fifty universities which account for nearly 70 percent of all doctorates granted in this country. Duke University is among the latter, as are most of the major institutions which offer programs ranging the breadth of academic disciplines. But even if one can narrow the field to about fifty major institutions, how does one select among these, and what factors should affect one's final choice? A few key factors are discussed briefly below.

**Size.** Size is not an infallible guide to the quality of a graduate school. There are a number of poor graduate schools of exceedingly large size and a number of extremely good small ones. However, it might be helpful simply to mention a few of the disadvantages of too many or too few students.

An extremely large graduate school — there are some which have between six and twelve thousand enrolled — is not the ideal of a small number of superior students working closely in intellectual pursuits with a few esteemed scholars. Classes of fifty to a hundred students, inaccessibility of senior faculty, shortage of library materials and facilities, and only a nodding acquaintance with fellow students are only a few of the

possible drawbacks. An able student may develop well even in this atmosphere of mass production, but it is hardly the ideal.

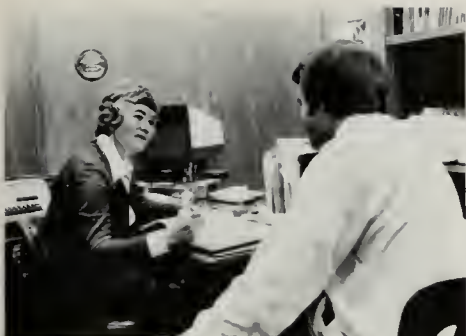
An extremely small graduate school also has its disadvantages. Facilities are often limited, and the faculty is likely to be primarily composed of undergraduate instructors. A university must be willing to commit a significant portion of its resources to develop a graduate program of high quality and this is often not the case in an extremely small graduate school.

More important than the size of the entire graduate school is the size of the particular departmental program in which a student is interested. An optimum doctoral program will have an enrollment of perhaps thirty to one hundred students, admitting fifteen to forty new students each year, and turning out perhaps three to ten Ph.D.s per year. This information is usually available in university catalogues or government publications on higher education.

Duke University is committed to programs of moderate size in which the interests of the student are important. Total enrollment in the Graduate School is about eighteen hundred students. Between four and five hundred new students are admitted each year from approximately four thousand applications. Only four departments have more than eighty students; seventeen departments have enrollments that fall within the optimum range suggested in the preceding paragraph.

**Quality.** Not only do universities differ considerably in their reputation for quality, but there are marked differences among departments within any university. Many excellent universities have a few weak departments in which a student would fare less well than in an excellent department in a less esteemed institution. Therefore, the student should not be guided solely by the reputation of a university as a whole, but should inquire more specifically about the area of specialization.

Since judging the quality of a graduate program is necessarily subjective, no two people are likely to be in complete agreement. Prospective students would do well to talk with their undergraduate professors, particularly those who have themselves achieved some reputation in the world of scholarship. As witnessed by their own continuing writing and research, they are more likely to have reliable information on the merits of various graduate programs. Similarly, younger faculty members who are



only four or five years out of graduate school may have more recent acquaintance with their own and other schools.

Another guide may be occasional questionnaires asking other educators to rank various graduate departments.

Alone, none of these guides is adequate; however, in conjunction with individual advice and recommendations, they can serve as useful indicators. In summary, the best procedure is to take as many factors as possible into account, and then to apply to three or four of the schools high in consideration. (Applying to fifteen universities is a waste of an applicant's and the universities' time.) Write to the graduate school or to the departmental director of graduate studies if further information is desired; visit the university in person, if possible; and carefully weigh the advice of distinguished faculty members of one's undergraduate college.

## Duration of Program

The length of time a graduate student spends in study toward an advanced degree depends upon the requirements of the individual program, on personal work habits,

and on the environment of the graduate school and the department in which the study is conducted.

The student's level of preparation before entering graduate school has a direct bearing on the speed with which the degree may be earned. A student who enters with proficiency in one or more foreign languages, and a good foundation in the chosen field may well be able to finish within the minimum time limits. On the other hand, the student who is not as well prepared may find that one and a half to two years are the minimum for the A.M. degree, and four to five years for the Ph.D. degree (although wise use of the summers may reduce this time somewhat). The total time may also be lengthened if the student must work during part of the period of residence.

The attitude of the graduate school and its various departments will also affect the time needed to complete the degree. During the last decade the average time elapsing between entering graduate school and receiving the doctorate in American universities has been about ten years. A study of experience at Duke during the early 1950s indicated that the average doctorate in the hu-



manities required a little over seven years, nearly six years in the social sciences, and slightly over four years in the sciences. Over the last few years, however, Duke University has been among the forerunners in reducing the time needed to obtain the Ph.D. without any sacrifice in quality. The effort has taken the form of trying to eliminate the unnecessary delays, particularly those due to financial burdens on the student. Duke ranks among the leading institutions in the country today in terms of financial aid per student from university sources. Moreover, much of this aid is in the form of fellowships and scholarships which do not require burdensome services in return. The large public institutions are often more restricted to awards which require substantial teaching, research, or other duties, thus reducing the speed with which a student can complete the resident course work. A student will be wise to inquire to what extent progress toward a degree may be delayed by the work entailed in certain awards. If, for example, an assistantship lengthens unduly the time necessary to obtain a degree, a smaller fellowship may be preferable.

Another way in which Duke encourages deliberate speed toward fulfilling degree requirements is through its tuition charges. Many graduate schools charge tuition for three full years in a doctoral program. In 1958 Duke adopted the policy of

charging full tuition and fees only up to the time the doctoral student passes the preliminary examination. (This examination is taken upon completion of all course and language requirements, usually at the end of the second year, before the student is formally admitted to candidacy for the Ph.D.) After "prelims," tuition charges are substantially reduced. In choosing a graduate school, a prospective student should inquire about the fees for a full doctoral program, not merely the charges for the first year. The tuition and fee system at Duke has worked to encourage both students and their departments to arrange for preliminary examinations to be taken before the beginning of the third year. Some years ago fewer than half of the doctoral students at Duke took this examination before the beginning of the third year; today over 90 percent are doing so. This plan, aided by scholarship and fellowship aid, gives graduate students at Duke a marked advantage over their counterparts in many other graduate schools in acquiring their degrees in the minimum amount of time.

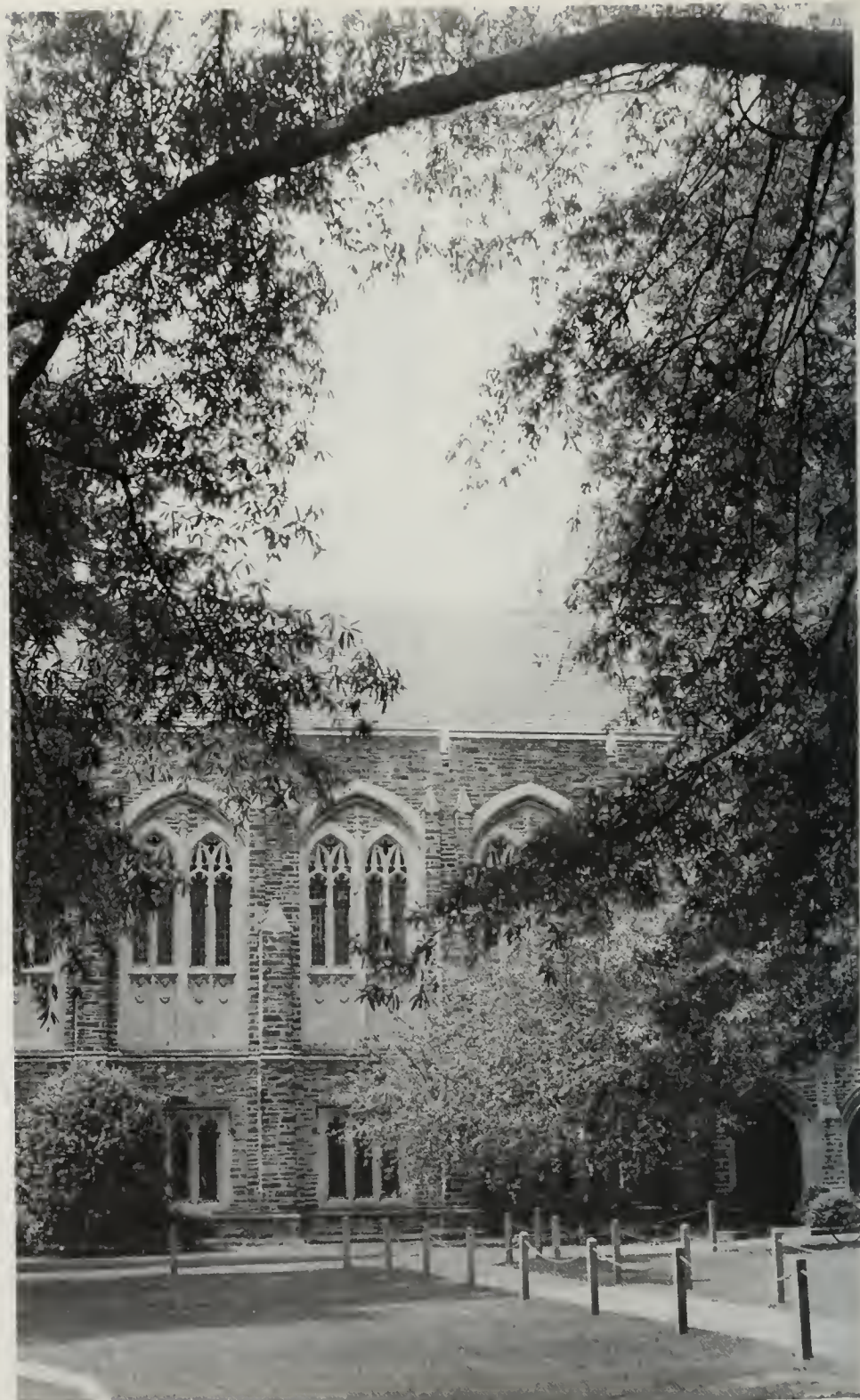
The duration of the graduate program, therefore, depends on many factors, but the policy of the Duke Graduate School is to keep the length of time a student is involved in obtaining an advanced degree at a minimum.

### Policy of Nondiscrimination

Duke University does not discriminate on the basis of race, color, national and ethnic origin, or sex in the administration of educational policies, admission policies, financial aid, employment, or any other University program or activity. It admits qualified students of any race, color, national and ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students.











# Duke University Graduate School

In surveying the progress made in the first seven years after the founding of Duke University, its first President, William Preston Few, wrote that he wanted "to see the Graduate School made strong because it will best and mostly quickly insure our attaining and maintaining a place of real leadership in the educational world." President Few believed that "more than anything else here our Graduate School will determine the sort of University we are to build and its standing in the educational world." These opinions have continued to prevail to the present day, with emphasis upon the interdependence of teaching and research as the necessary components of scholarship.

Over five hundred members of the graduate faculty teach the approximately six hundred courses and seminars offered in the Graduate School, and supervise thesis and dissertation research. Many of the major universities of the world have helped to train this faculty; approximately 90 percent of the graduate staff hold degrees from the forty-six institutions which make up the Association of Graduate Schools within the Association of American Universities. By place of birth they represent almost every state in the nation and almost two dozen foreign countries.

The eighteen hundred graduate students currently enrolled represent a similar

diversity in background. Approximately 41 percent of the students recently completing doctoral degrees are from undergraduate colleges in the southeast, 16 percent from the middle Atlantic states, 12 percent from New England, 11 percent from the central states, 7 percent from the southwest, 2 percent from the northwest, 1 percent from the far west, and 10 percent from foreign countries.

The groundwork for learning may be laid in privacy — indeed a certain amount of private study and research is absolutely essential — but the vital stimulus to the learning process comes from one's contact with the minds of other people with similar or related interests. This is precisely why graduate schools are highly selective in their admissions policy, and it is one of the important reasons for their willingness to offer attractive fellowship awards to outstanding students. The superior student is a valuable catalyst both for fellow students and for faculty and is prized as such.

Faculty and students comprise the essential human factors in education, but their joint endeavor cannot prosper without adequate research and library facilities. Duke University has research facilities for physics, botany, zoology, chemistry, psychology, sociology, engineering, and biochemistry. These laboratories have been built entirely

within recent years, and modernization and expansion have occurred in other scientific areas. The University has an excellent Computation Center on the campus and shares a computing facility with the University of North Carolina and North Carolina State University. The Triangle Universities Computation Center is among the largest research-oriented computer facilities in the world. The University has a fine research library; the twentieth largest university library in the nation, second in the south, and first in the southeast. In number of volumes, breadth of coverage, serials, and documents, it is a much more adequate library than that available in many graduate schools with an enrollment two or three times as large. To the student in the arts, humanities, and social sciences, for whom the library is the bloodstream of scholarship, this is an immeasurable asset.

Among the many special features of the Graduate School a few important examples may be mentioned. For students in the biological and physical sciences, the facilities of the Duke Marine Laboratory at Beaufort, North Carolina, are available for course

work and research. The Laboratory has research buildings, classrooms, motor vessels (including the 118-foot oceanographic ship, the *R/V Eastward*, and a new research vessel, the 62-foot *R/V John de Wolfe II*), and living quarters, which make it an excellent research center in marine biology. Closer to home are the 8,000 acres of Duke Forest, managed by the School of Forestry, ideal for research on timber growth, soils, and related topics. A Regional Nuclear Structure Laboratory is housed on the campus and serves the major universities in the area. The phytotron, adjacent to the botany greenhouses, is an integrated series of plant-growth rooms, chambers, and greenhouses, with forty-six separately controlled environments providing more than 4,000 square feet of plant-growing space. The factors of the environment controlled in the units to study plant growth include light, temperature, nutrients, CO<sub>2</sub> concentration, and humidity.

Additional resources and facilities are available to the graduate student because of Duke's fine Schools of Law, Medicine, Engineering, Forestry, and Divinity. A three-term summer session and the availability of courses at the nearby University of North Carolina at Chapel Hill, North Carolina Central University in Durham, and North Carolina State University at Raleigh under a cooperative arrangement offer other opportunities to the graduate student.

No description of programs can begin to give the prospective student the full flavor of graduate study in a particular institution. A visit to the universities in which one is particularly interested may be helpful in giving one a better picture. If this should be practical, the Duke Graduate School offers a warm invitation to prospective students to come to the campus during the year to discuss their possible application and admission. The visitor will find at Duke most of the facilities that one could hope for in the largest of institutions, and yet the University has been fortunate in avoiding many of the evils inevitable with mass education. Despite the total University enrollment of approximately 9,000, Duke has retained the sense of community that one usually associates with a smaller liberal arts college. And in an age when current architectural whim often adds yet one more variant style to an already assorted array of buildings, Duke has built a campus of unusual and architecturally coherent beauty. This, too, is an important part of education, creating an environment conducive to learning.





## Special Programs

Special and cooperative programs at Duke include:

Center of the Study of Aging and Human Development

Canadian Studies Program

Center for Commonwealth Studies

Program in Comparative Studies on Southern Asia

Cooperative Program in Teacher Education (Secondary M.A.T. Degree)

Cooperative Program (with the University of North Carolina at Chapel Hill) in Russian and East European History

Center for Demographic Studies

Duke Environmental Center

University Program in Genetics

Hispanic Studies Program

Medical Scientist Training Program

Medical Historian Training Program

Program in Medieval and Renaissance Studies

Predoctoral Training Program in Sciences Related to the Nervous System

Oak Ridge Institute of Nuclear Studies

Organization for Tropical Studies

Institute for Policy Sciences and Public Affairs

Round Table on Science and Public Affairs

Social Systems Simulation Program

Center for Southern Studies (including the Oral History Project)

Further information may be obtained by writing the individual program c/o Duke University, Durham, North Carolina 27706 or by writing the Graduate School Office.

## General Regulations Governing Graduate Studies

The official detailed *Bulletin of the Graduate School*, published in March of each year, gives an account of regulations concerning graduate work at Duke University and a full description of course content. The following pages are a summary of these materials for 1977-78 and should provide sufficient information for the prospective student. The *Bulletin* is normally mailed to each student who is admitted to the Graduate School in the late spring of the year of matriculation so that the course program may be planned for the first year. Copies may be obtained in April, however, by writ-

ing to the Graduate School Office, Duke University, Durham, North Carolina 27706.

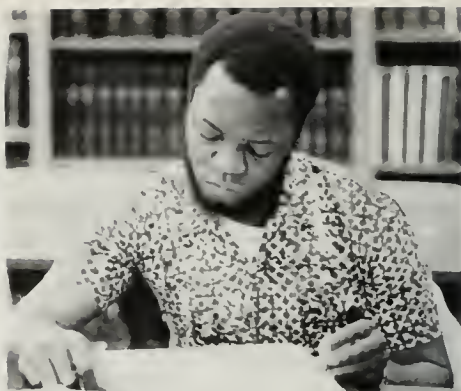
## Admission

All applicants will be considered without regard to race, color, religion, sex, or national origin.

Admission is required of (1) all students who intend to pursue study toward a degree offered by the Graduate School, (2) all other students who desire credit for whatever purpose for graduate courses — except students who register as special students in the Summer Session. Students who have discontinued a program of study after earning a master's degree here must by letter request permission of the Dean to undertake a doctoral program.

A student seeking admission to the Graduate School of Duke University must have received an A.B. or B.S. degree (or the equivalent in the case of foreign students) from an accredited institution. The student's undergraduate program should be well rounded and of such quality as to give positive evidence of capacity for graduate study. Ordinarily the student should have majored in the area of intended graduate study. Many departments (see the section on Advanced Degree Programs at Duke) list specific prerequisites. Students are urged to anticipate the language requirement and are reminded that Educational Testing Service Graduate School Foreign Language Tests in French, German, Russian, and Spanish are offered to undergraduate and graduate students at many centers on nationally uniform dates (see the section on Language Requirement).

**Procedures.** A student seeking admission to the Graduate School should request the Dean of the Graduate School to send an application blank. This should be filled out completely and returned promptly. Each application must be accompanied by a nonrefundable fee of fifteen dollars in check or money order payable to Duke University. In addition, the student is required to provide the following supporting documents: (1) two copies of the official transcript from each college, university, or seminary attended sent to the Dean directly by the institution; (2) as soon as possible, two supplementary transcripts showing completion of work which was in progress when the earlier transcript was made; (3) three letters of recommendation, written on the forms provided, by persons best qualified to judge the appli-



cant as a prospective graduate student, and mailed directly to the Dean; (4) scores on the Graduate Record Examination Aptitude Test for all departments; and (5) scores on the Graduate Record Examination Advanced Test for the Departments of Biochemistry, Botany, Chemistry, English, Mathematics, Microbiology, Pathology, Physics, Physiology, Romance Languages, Sociology, and Zoology.

Applicants to the Department of Health Administration are also required to take the Graduate Management Admission Test, administered by the Educational Testing Service.

Students applying for financial aid in all departments should take the Graduate Record Examination no later than the October testing in order to meet the February 1 deadline. Information on times and places of

the Graduate Record Examinations can be provided at the applicant's college or by the Educational Testing Service, Princeton, New Jersey 08540, or Berkeley, California 94704.

Fully qualified students from outside the United States are welcome to take courses in the Graduate School and, in many instances, to study toward a degree. In applying for admission the foreign student must, in addition to the information required of all students, submit with application materials (1) if the student's native language is not English, certification of English proficiency demonstrated by scores from the Test of English as a Foreign Language (TOEFL), administered through the Educational Testing Service in Princeton, New Jersey; (2) a statement showing financial arrangements for the proposed term at Duke (estimated costs per calendar year are \$7,200), and (3) a statement by a qualified physician describing any emotional or physical illness the applicant has had during the previous five years. A foreign student must meet all these requirements before the Graduate School will make any offer of admission.

All foreign students whose native language is not English will be examined during their first registration period for competence in the use of oral and written English. Until competence is determined, admission and arrangements for an award involving teaching must remain provisional. Students found to lack the necessary competence will be required to enroll in the non-credit course called English for Foreign Students and to reduce their course or research program by 3 units.

A student who does not successfully complete this course during the first year of residency will not be permitted to continue graduate work at Duke University. Passing this examination or the course, if it is required, will not meet degree requirements

for a foreign language.

When admission is approved, the student will receive a letter of admission and an acceptance form. The process of admission is not complete until the student returns the acceptance form.

Applicants who are admitted will be offered full admission, provisional admission, or nondegree admission. *Provisional admission* for a trial period of one semester or a minimum of 12 hours of course work is offered to students who appear to warrant admission but do not fully comply with admission requirements. Graduate credit earned under provisional status may be applied toward an advanced degree at Duke University if and when the student is granted full admission. *Nondegree admission* is offered to students who meet the admission requirements and who desire to engage in graduate study not subject to the restrictions of a graduate degree program. With the approval of the student's major department and the Dean of the Graduate School, a maximum credit of 6 units earned under nondegree status may be applied toward an advanced degree at Duke University if and when the student is granted full admission.

It is the applicant's responsibility to make certain that the Graduate School Office has received all required material before the specified deadlines. Because applications cannot be reviewed until all supporting documents are filed, applications should be submitted two weeks before the closing dates listed below.

We encourage all candidates to apply by February 1. Anyone whose folder is not complete before that date will face the possibility that departmental enrollment will have been filled. Although the Graduate School Office will process later applications, it cannot guarantee full consideration of a folder for any department after April 15.

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Fall semester, admission and award .....	February 1
Fall semester, admission only .....	July 15
Spring semester, admission only .....	November 1
Summer session, 1978* first term .....	April 15
Summer session, 1978* second term .....	May 15
Summer session, 1978* third term .....	June 15

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\*Students seeking admission to the Graduate School for study in the summer session should apply to the Dean of the Graduate School and to the Director of the Summer Session.



## Earning the Degrees

Duke University offers graduate programs leading to the specified advanced degrees in the following fields:

Anatomy, A.M., Ph.D.  
Anthropology, Ph.D.  
Art History, A.M.  
Biochemistry, Ph.D.  
Biomedical Engineering, M.S., Ph.D.  
Botany, A.M., M.S., M.A.T., Ph.D.  
Business Administration, Ph.D.  
Chemistry, A.M., M.A.T., Ph.D.  
Civil Engineering, M.S., Ph.D.  
Classical Studies, Ph.D.  
Computer Science, A.M., Ph.D.  
Economics, A.M., Ph.D.  
Education, M.Ed., M.A.T., A.M., Ed.D., Ph.D.  
Electrical Engineering, M.S., Ph.D.  
English, A.M., M.A.T., Ph.D.  
Forestry, A.M., M.S., Ph.D.  
Geology, M.S., Ph.D.  
Germanic Languages and Literature, A.M.  
Health Administration, M.H.A.  
History, A.M., M.A.T., Ph.D.  
Mathematics, A.M., M.A.T., M.S., Ph.D.  
Mechanical Engineering and Materials Science, M.S., Ph.D.  
Microbiology and Immunology, Ph.D.  
Pathology, M.S., Ph.D.  
Philosophy, A.M., Ph.D.  
Physical Therapy, M.S.  
Physics, A.M., Ph.D.  
Physiology and Pharmacology, Ph.D.  
Political Science, A.M., Ph.D.  
Psychology, Ph.D.  
Public Policy Sciences, A.M. (Joint Degree)  
Religion, A.M., Ph.D.  
Romance Languages, A.M., Ph.D.  
Sociology, Ph.D.  
Zoology, A.M., M.A.T., Ph.D.

## The Language Requirement

Although individual departments establish their own minimal requirements (see individual departmental headnotes in this *Bulletin*), the regulations of the Graduate School require no foreign language for the master's degree, and, in most departments, a reading knowledge of one foreign language, ancient or modern, for the Ph.D. degree. The languages normally required are French, German, and Russian, but others may be offered if appropriate and approved. The foreign language requirement may be satisfied in the following ways: (1) by a pass-

ing score on one of the ETS examinations administered at any national center (including Duke) and taken no longer than six years before the preliminary examination, (2) by transfer from another institution, with the limitations set forth in the more detailed *Bulletin of the Graduate School*, (3) in any language for which ETS tests are not available, by a reading examination administered by a qualified examiner and arranged by the Graduate School Office, or (4) by a reading examination in any foreign language, administered by a qualified member of the faculty under a procedure specified by the department and approved by the Dean and the Executive Committee of the Graduate Faculty.

Advanced level, non-credit reading courses in French and German are provided for students who need them.

In special circumstances a department that wishes to do so may ask the Dean and the Executive Committee of the Graduate Faculty to waive the language requirement.

## Other Requirements

The general requirement for a master's degree is a minimum of 30 units (semester hours) of course-seminar-research credit. The student must present acceptable grades for a minimum of 24 units of graduate courses. The nature of the additional 6 units for which students must register depends on whether they are enrolled in thesis or non-thesis programs; i.e., these last 6 units are earned either with successful submission of the thesis or with such other courses or academic exercises as are approved by the students' departments. In the M.A.T. program, practice teaching is included for students who lack it, and for those students a minimum of 36 units is the number required. A pattern of major and related work is prescribed for the course-seminar work, allotting half or more of the units to the major. For example, the M.Ed. program allows at least half of the units to fall within the student's teaching field, and the M.A.T. allows a major in either education or in teaching fields, according to the student's previous training.

A master's program can be completed in one academic year, but the student who presents a thesis usually needs at least a calendar year, and foreign students should be prepared to study for two years. The maximum length of time permitted from first registration to completion of all require-



ments is six years. Under certain circumstances a maximum credit of 6 units may be transferred toward the master's degree for graduate courses completed elsewhere, provided the grades earned in the particular courses were not less than *B* or equivalent. In such a case, however, the transfer of graduate credit does not reduce the required minimum registration for a master's degree at Duke.

The course-seminar-research requirement in the doctoral program is a minimum of 60 units, but the proportions of course-seminar work and research are generally flexible, based on individual needs. Those applicants with master's degrees, after establishing quality work here, may be granted transfer credit to a maximum of 30 units, i.e., the equivalent of one year of residence. The dissertation is expected to be a mature and competent piece of writing, embodying the results of original and significant research. All dissertations will be published on microfilm, and the author may retain copyright privileges.

Time limitations are set for the completion of the doctoral program. The preliminary examination, which may be taken only after language, course-seminar, and residence requirements have been met, formally admits a student to candidacy for the degree. This examination should be passed by the end of the third year of doctoral study. The interval between preliminary examination and presentation of an acceptable dissertation should ordinarily be one to two years and may not be more than four years without special approval by the Dean. Should this interval extend beyond five years, a second preliminary examination usually becomes necessary.

### Financial Information\*

Tuition and fees are charged at the rate of \$117 per unit (a unit is equivalent to a semester hour), with the normal full program of study being 30 units for an academic year. Upon successful completion of the preliminary examination and two years of residence, the normal full program during the dissertation period is 3 units per semester while in residence, or 1 unit per semester while not in residence. The basic necessary expenses for a year of graduate study, assuming one lives in University graduate dormitories, are therefore approximately as follows:

	<i>First and Second Year</i>	<i>Dissertation Year</i>
Tuition	\$3510	\$702
Health Fee	86	86
Room Rent† (Graduate Center)	689	689
Board‡	925	925

Additional allowances should be made for books, laundry, and other personal expenditures.

Housing is provided for approximately ninety graduate and professional school students in the Graduate Center. The Town House Apartments, located between East and West Campuses, will accommodate both families and single students in thirty air-conditioned apartments.

Central Campus Apartments accommodate married and single students from the University and the Medical Center.

For single graduate professional students, one-bedroom and three-bedroom apartments will be furnished; a few furnished efficiencies are available. It is expected that many more applications will be received for efficiencies than can be accommodated.

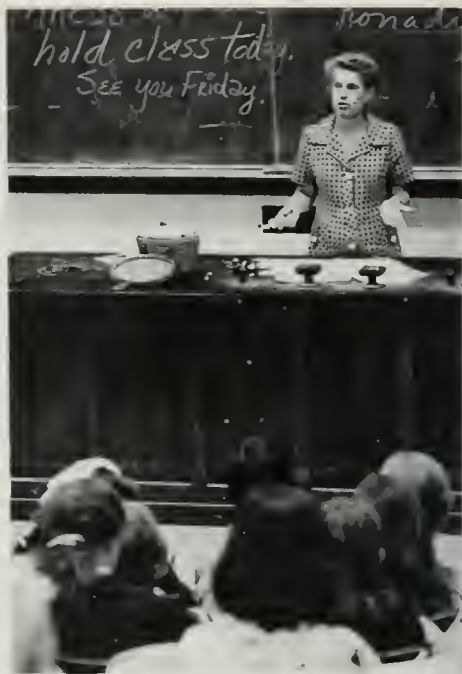
**Financial Aid.** In recent years at Duke about two-thirds of all full-time students have held an award of some type; about one-third of these were aided by Duke funds and the other two-thirds by funds from other sources.

The student who seeks financial aid from Duke University should be certain that the request for admission and award is filed not later than February 1 of the year in which September admission is sought. The application for admission, including transcripts of previous college work and letters of recommendation, is processed by the Graduate School and forwarded to the department in which the student wishes to pursue advanced work. The graduate faculty — or admissions committee — in the department reviews all applications and then makes its recommendation to the Dean for announcement in late March. The most outstanding applicants are then offered awards; the next in order of rank are placed on an al-

\*The figures contained in this section are subject to change prior to the beginning of the fall, 1977, semester.

†Depending upon accommodations chosen.

‡Cafeteria estimate.



ternate list for awards. Other students are offered only admission to the Graduate School. Because of multiple applications by students, a fraction of the awards offered by any graduate school are turned down. Alternates on the award list are immediately notified, and the process continues until the desired number of awards has been made.

Awards to entering students at Duke are in the form of fellowships, scholarships, and assistantships.

**James B. Duke Graduate Fellowships** are provided through a special endowment of the Duke Endowment. Fellows are chosen from nominations made by the departments. Only outstanding applicants who are seeking the Ph.D. degree are considered. These nominations are made in late February and are judged in a competition which includes candidates from all departments granting the Ph.D. degree. These fellowships provide for payment of tuition for full registration and a stipend of \$350 per month for the full calendar year during each of the three years of the award. The award requires no service beyond that which is required of all students in a given department as a part of their training and is renewable each year upon satisfactory progress toward the degree at a fellowship level of quality. The total value of a James B. Duke Fellowship over the full three years of tenure is over \$20,000 at current tuition rates.

**Graduate Fellowships** range in value to \$6,000 for the academic year and are made on a year-to-year basis. They are awarded upon recommendation by each department. No service is required as a prerequisite for accepting a fellowship, but all fellowship holders are expected to maintain full-time registration.

**Special Graduate Fellowships for Black American Students** provide for payment of tuition plus stipend for a total value of \$6,296. They are awarded for one year to qualified applicants upon the recommendation of the department.

**Graduate Scholarships** provide for payment of tuition or partial tuition. Full tuition scholarships are valued at \$3,510 for the academic year. Scholarships are awarded upon recommendation of each department.

**Graduate Assistantships** range in value to \$4,800 for the academic year. Assistants may be permitted to reduce their registration to 12 or 9 units, depending on the amount of service required. Residence credit as a full-time student is allowed under these circumstances. Assistantships are most common in the science departments, where the student often provides laboratory assistance to various members of the faculty. Most graduate assistants remain in residence during the summer sessions carrying research or course credit. In this way, the normal

progress toward a degree is not impeded by the reduced load during the fall and spring semesters. Departmental research funds are often available to provide financial assistance during the summer.

Other graduate fellowships are available from foundations, industry, or the government. Among those at the University's disposal are James B. Duke Commonwealth Fellowships for students in political science, economics, and history who are concentrating their studies on the British Commonwealth; Kearns fellowships in religion; Mellon Fellowships and traineeships under a grant from the Office of Education for students in the Canadian Studies Program; Medieval and Renaissance Studies fellowships; and Cokesbury awards for the preparation for college teaching. In 1976-1977, three students held Foreign Language Fellowships awarded by Duke University under Title VI of the National Defense Education Act in Southeast Asia Area Studies. Over 300 other traineeships and assistantships are available in the biological, physical, and social sciences under grants from the National Institutes of Health, National Institutes of Mental Health, National Science Foundation, research agencies in the Department of Defense, and other governmental agencies.

Loans may be obtained through the National Direct Student Loan Fund and through the Federal Insured Student Loan Program. In addition, the University provides loans from funds set aside for this purpose. Particular eligibility requirements

must be met for each program. All of the above loans require that need criteria be met, but funds under favorable terms are expected to be available to meet legitimate requests. Further information may be obtained from the Graduate School Office.

**Estimate of Expenses.** It is difficult to estimate a student's financial needs during the years of graduate study because of individual tastes and habits. One can predict with some accuracy, however, the three major items of expense at Duke: tuition, \$3,510 for a full program for each of the first two years, usually \$702 for the Ph.D. dissertation year; room rent, \$689 each year in graduate dormitories; and board, approximately \$925 in graduate dining halls. Students holding awards are usually paid in nine equal installments beginning in late September, and tuition and room fees may be deducted monthly on a pro rata basis.

The costs of graduate education are high, but Duke University attempts to allocate its funds so that the superior student is able to finish work for a degree in the normal length of time regardless of personal financial resources. This is a contribution to the community of scholarship which the University is glad to bear.

The applicant who wishes further information on facilities and regulations on course programs not covered in this *Bulletin* is invited to write to the Dean of the Graduate School, or the director of graduate studies in the department of intended study.

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## Calendar of the Graduate School

### Summer Session 1977

First Term: May 10-June 11  
Second Term: June 13-July 15  
Third Term: July 18-August 19

### Academic Year 1977-1978

First Semester: September 6-December 21  
Second Semester: January 9-May 1

August 29-31 .....	Registration for First Semester
September 6 .....	Classes Begin
November 22-28 .....	Thanksgiving Recess
December 8-13 .....	Reading Period
December 21 .....	End of First Semester
January 6 .....	Registration for Second Semester
January 9 .....	Classes Begin
March 3-13 .....	Spring Recess
April 18-24 .....	Reading Period
May 1 .....	End of Second Semester
May 7 .....	Commencement

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# Advanced Degree Programs\*

## Anatomy

### Professors

John Wendell Everett, Ph.D. (Yale); J. Moses, Ph.D. (Columbia); Talmage Lee Peele, M.D. (Duke); J. David Robertson, M.D. (Harvard), Ph.D. (Massachusetts Inst. of Tech.), *James B. Duke Professor of Anatomy and Chairman*.

### Associate Professors

Matthew Cartmill, Ph.D. (Chicago); Sheila J. Counce, Ph.D. (Edinburgh); Kenneth Lindsay Duke, Ph.D. (Duke); Harold Erickson, Ph.D. (Johns Hopkins); William C. Hall, Ph.D. (Duke); William Hylan-der, Ph.D. (Chicago), *Director of Graduate Studies*; William Longley, Ph.D. (London); Michael K. Reedy, M.D. (Washington).

### Assistant Professors

Mark Adelman, Ph.D. (Chicago); Charles Blake, Ph.D. (California at Los Angeles); Joseph Corless, M.D., Ph.D. (Duke); William Fletcher, Ph.D. (California at Berkeley); Kurt E. Johnson, Ph.D. (Yale); Richard F. Kay, Ph.D. (Yale); Moses S. Mahaley, M.D., Ph.D. (Duke); Timothy Strickler, Ph.D. (Chi-cago); Lee Tyrey, Ph.D. (Illinois).

### Lecturer

Irving T. Diamond, Ph.D. (Chicago).

### Adjunct Assistant Professor

Jan Bergeron, V.M.D. (Pennsylvania).

The Department of Anatomy offers graduate programs designed to produce teachers and research workers competent in a broad range of anatomical sciences; A.M. and Ph.D. degrees are offered. Students with a wide variety of backgrounds and interests in the biological sciences can be accommodated. All students participate in a core of anatomical science courses (Anatomy 305, 307, 309) and gain experience in teaching over the range of depart-mental interests. Students are encouraged to round out their formal course work by drawing upon the offerings of other departments in the University, as well as those in the Anatomy

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\*For full course descriptions including credit and name of instructor see the official detailed *Bulletin of the Gradu-ate School*.

ical sciences can be accommodated. All students participate in a core of anatomical science courses (Anatomy 305, 307, 309) and gain experience in teaching over the range of departmental interests. Students are encouraged to round out their formal course work by drawing upon the offerings of other departments in the University, as well as those in the Anatomy Department. Laboratories within the department are equipped for and actively support research in several areas. For further information contact the Director of Graduate Studies.

#### Courses of Instruction

- |   |  |
|---|--|
| 207. Human Anatomy                                      | 276. Neuroanatomical Basis of Sensory Physiology                                     |
| 208. Anatomy of the Trunk                               | 280. Structure and Assembly of Macromolecules  |
| 212. Cellular Endocrinology                             | 286. The Light Microscope, the Electron Microscope, and X-ray Diffraction in Biology |
| 215. Contractile Processes                              | 288. Seminar on the Role of the Cell in Development and Heredity                     |
| 216. Biological Psychology                              | 291. Special Topics in Nerve Ultrastructure  |
| 217. Structure and Function of Visual Photoreceptors    | 300. Gross Anatomy   |
| 219. Molecular and Cellular Basis of Development        | 303. Neuroanatomical Basis of Behavior   |
| 219S. Seminar   | 305. Gross Human Anatomy   |
| 231. Human Evolution                                    | 307. Microscopic Anatomy   |
| 238. Functional and Evolutionary Morphology of Primates | 309. Neuroanatomy  |
| 240. Mechanisms of Biological Motility                  | 312. Research  |
| 246. The Primate Fossil Record                          | 313, 314. Anatomy Seminar  |
| 261. History of Generation and Mammalian Reproduction   | 340. Tutorial in Advanced Anatomy  |
| 263. History of Anatomy                                 | 344. Advanced Neuroanatomy of Sensory and Motor Mechanisms                           |
| 264. Mammalian Embryology and Developmental Anatomy     | 354. Research Techniques in Anatomy  |
| 265. Seminar in Chromosome Biology                      | 418. Reproductive Biology  |
| 266. Seminar in Chromosome Biology                      |  |

## Anthropology

#### Professors

Richard G. Fox, Ph.D. (Michigan), *Director of Graduate Studies*; Ernestine Friedl, Ph.D. (Columbia), *Chairman*; Weston LaBarre, Ph.D. (Yale), *James B. Duke Professor of Anthropology*.

#### Associate Professors

Mahadev L. Apte, Ph.D. (Wisconsin); Matthew Cartmill, Ph.D. (Chicago); William Hylander, Ph.D. (Chicago); William M. O'Barr, Ph.D. (Northwestern); Lawrence Rosen, J.D., Ph.D. (Chicago); Carol A. Smith, Ph.D. (Stanford).

#### Assistant Professors

Kenneth E. Glander, Ph.D. (Chicago); Teresa Graedon, Ph.D. (Michigan); Naomi Quinn, Ph.D. (Stanford); Carol Stack, Ph.D. (Illinois).

The department offers graduate work leading to the Ph.D degree in anthropology. Applicants for admission should submit scores on the Graduate Record Examination Aptitude Test.

Candidates for the Ph.D. degree must demonstrate a general competence in four major sub-fields (sociocultural anthropology, physical anthropology, anthropological linguistics, and prehistory) as well as specialization in one or more of these sub-fields. Recognizing a trend in modern anthropology toward interdisciplinary research, the department allows the student to replace some of the course work required for the Ph.D. degree by advanced work in anatomy, economics, psychology, sociology, zoology, or other disciplines relevant to a student's program.

Further details of the graduate program in anthropology, the departmental facilities, the staff, and various stipends available are described in the *Guidelines for Graduate Students in Anthropology* which may be obtained from the Director of Graduate Studies, Department of Anthropology.

## Courses of Instruction

- |  |   |
|--|---|
| 210. Linguistic Anthropology: Theory                       | 269. Topics in Law and the Social Sciences  |
| 211. Linguistic Anthropology: Ethnography of Communication | 270. Ethnographic Field Methods   |
| 220S. Society and Culture in India                         | 271. Methods of Data Analysis   |
| 222. Topics in African Anthropology                        | 272. Primitive Music  |
| 242. Topics in Prehistory                                  | 273. Primitive Art  |
| 243. Theory and Method in Archeology                       | 275. Rank, Power, and Authority in Pre-Industrial Societies                         |
| 244. Primate Behavior                                      | 276. Analysis of Kinship Systems  |
| 245. Functional and Evolutionary Morphology of Primates    | 277. Class, Ethnicity, and Public Policy  |
| 246. The Primate Fossil Record                             | 278S. Special Topics in Political Anthropology                                      |
| 249. Topics in Economic Anthropology                       | 280S, 281S. Seminar in Selected Topics  |
| 250. The Anthropology of Cities                            | 291, 292. Anthropological Theory  |
| 251. Ethnography of Humor                                  | 330, 331. Seminar in Anthropology   |
| 259. Linguistic Anthropology: Language Acquisition         | 334. Topics in Physical Anthropology  |
| 264. Primitive Religion                                    | 335, 336. Linguistic Theory and Methods   |
| 265. Personality and Society                               | 393. Individual Research in Anthropology  |
| 266. Personality and Culture                               | 402. Interdisciplinary Seminar in the History of the Social Sciences                |
| 267. Cognitive Anthropology                                | 410. Seminar in the Government, History, and Social Structure of India and Pakistan |
| 268. Law and the American Indian                           |   |

## Art

### Professors

Marianna Jenkins, Ph.D. (Bryn Mawr); Sidney David Markman, Ph.D. (Columbia), *Director of Graduate Studies*; Earl George Mueller, Ph.D. (Iowa); Elizabeth Read Sunderland, Ph.D. (Radcliffe).

### Assistant Professors

Charlotte Brown, A.B. (North Carolina at Greensboro); John L. Connolly, Jr., Ph.D. (Pennsylvania); Sara Lichtenstein, Ph.D. (London).

Graduate work in the Department of Art is offered leading to the A.M. degree in art history and is designed to provide basic training in the history of art with specialization in a given field selected by the student after consultation with and approval of the Director of Graduate Studies. Prospective students should present a minimum of 24 semester hours of undergraduate work in the history of art. In special cases a student who does not fulfill this prerequisite may be required to attend prescribed undergraduate courses. A reading knowledge of one foreign language (preferably German) is required; candidates who do not meet this requirement upon admission to the program are expected to do so by the end of their first term in residence.

The program for the A.M. degree in art history consists of 30 units as follows: 12 units in art history; 6 units in an approved minor; 6 units in the major or minor, or other approved subject; and 6 units in thesis. A written thesis is required. Candidates must also pass written comprehensive examinations testing their knowledge of art history and pertinent bibliographical resources.

## Courses of Instruction

- |   |   |
|---|---|
| 233. Early Medieval Architecture                  | 250. Problems in Latin American Art       |
| 237. French Renaissance Art                       | 254. Problems in Modern Architecture      |
| 244. Neoclassicism                                | 257, 258. Problems in Modern Art          |
| 247. Problems in the History of Graphic Arts      | 259. Romanticism                          |
| 249. Problems in Pre-Columbian Art and Archeology | 293, 294. Special Problems in Art History |

## Asian Languages

These courses are offered as enrichment for students interested in the South Asian sub-

continent and may be taken as a general elective by advanced undergraduate students. No major work is offered in Hindi-Urdu.

Hindi-Urdu 200-201. Special Studies in South Asian Languages

Hindi-Urdu 203. Studies in Commonwealth Literature

## Biochemistry

### Professors

Irwin Fridovich, Ph.D. (Duke); Samson R. Gross, Ph.D. (Columbia), *Director of the Genetics Division*; Walter R. Guild, Ph.D. (Yale); Philip Handler, \* Ph.D. (Illinois); Jerome S. Harris, M.D. (Harvard); Robert Hill, Ph.D. (Kansas), *James B. Duke Professor of Biochemistry and Chairman*; Henry Kamin, Ph.D. (Duke); Norman Kirshner, Ph.D. (Pennsylvania State); Kenneth S. McCarty, Ph.D. (Columbia); K.V. Rajagopalan, Ph.D. (Univ. of Madras), *Director of Graduate Studies*; Charles Tanford, Ph.D. (Princeton), *James B. Duke Professor of Biochemistry*; Robert E. Webster, Ph.D. (Duke).

### Associate Professors

Stanley H. Appel, M.D. (Columbia); Ronald C. Greene, Ph.D. (California Inst. of Tech.); Bernard Kaufman, Ph.D. (Indiana); Sung-Hou Kim, Ph.D. (Pittsburgh); William Sanford Lynn, Jr., M.D. (Columbia); Jacqueline A. Reynolds, Ph.D. (Washington); David C. Richardson, Ph.D. (Massachusetts Inst. of Tech.); Harvey J. Sage, Ph.D. (Yale); Lewis M. Siegel, Ph.D. (Johns Hopkins); James B. Sullivan, Ph.D. (Texas).

### Assistant Professors

Robert Bell, Ph.D. (California at Berkeley); Robert L. Habig, Ph.D. (Purdue); Dwight H. Hall, Ph.D. (Purdue); Edward W. Holmes, M.D. (Pennsylvania); Nicholas M. Kredich, M.D. (Michigan); Robert J. Lefkowitz, M.D. (Columbia); P. A. McKee, M.D. (Oklahoma); Robert W. Wheat, Ph.D. (Washington Univ.).

### Associates

John A. Bittikofer, Ph.D. (Purdue); Yasuhiko Nozaki, Ph.D. (Univ. of Tokyo).

### Assistant Medical Research Professors

Joseph Bonaventura, Ph.D. (Texas); Joe M. McCord, Ph.D. (Duke); Howard Steinman, Ph.D. (Yale).

Graduate work in the Department of Biochemistry is offered leading to the Ph.D. degree. Preparation for such graduate study may take diverse forms. Undergraduate majors in chemistry, biology, mathematics, or physics are welcome, but adequate preparation in chemistry is essential. Graduate specialization areas include protein structure and function, crystallography of macromolecules, nucleic acid structure and function, lipid biochemistry, membrane structure and function, molecular genetics, enzyme chemistry, and neurochemistry. The Division of Genetics of the department, in cooperation with the University Program in Genetics, offers biochemistry students the opportunity to pursue advanced research and study to fulfill the requirements for the Ph.D. degree.

### Courses of Instruction

- |   |   |
|---|---|
| 204. Introductory Genetics                              | 241. General Biochemistry                               |
| 209-210. Independent Study                              | 248. Introductory Biochemistry                          |
| 216. Molecular Genetics                                 | 276. Comparative and Evolutionary Biochemistry          |
| 219. Molecular and Cellular Basis of Development        | 282. Experimental Genetics                              |
| 219L. Laboratory  | 284. Current Topics in Genetic Mechanisms               |
| 219S. Seminar   | 286. Current Topics in Immunochemistry                  |
| 220. Adaptations of Organisms to the Marine Environment | 288. The Carbohydrates and Lipids of Biological Systems |
| 222. Structure of Biological Macromolecules             | 290. Bioenergetics                                      |
| 224. Biochemistry of Development and Differentiation    | 291. Physical Biochemistry                              |
|   | 292. Proteins and Enzymes                               |

\*On leave of absence.



- 296. Biological Oxidations
- 297. Intermediary Metabolism
- 299. Nutrition
- 302. Neurochemistry

- 345, 346. Biochemistry Seminar
- 351, 352. Genetics Seminar
- 390. Biochemistry of Membranes

## Botany

### Professors

Lewis Edward Anderson, Ph.D. (Pennsylvania); William Dwight Billings, Ph.D. (Duke), *James B. Duke Professor of Botany*; William Lewis Culberson, Ph.D. (Wisconsin); Henry Hellmers, Ph.D. (California at Berkeley); Terry W. Johnson, Jr., Ph.D. (Michigan); Aubrey Willard Naylor, Ph.D. (Chicago), *James B. Duke Professor of Botany*; Jane Philpott, Ph.D. (Iowa); Donald E. Stone, Ph.D. (California at Berkeley); Richard A. White, Ph.D. (Michigan); Robert L. Wilbur, Ph.D. (Michigan), *Chairman*.

### Associate Professors

Janis Antonovics, Ph.D. (Univ. Coll. of North Wales); Richard T. Barber, Ph.D. (Stanford); John E. Boynton, Ph.D. (California at Davis); Kenneth R. Knoerr, Ph.D. (Yale); Richard B. Searles, Ph.D. (California at Berkeley), *Director of Graduate Studies*; Boyd R. Strain, Ph.D. (California at Los Angeles).

### Assistant Professors

Norman L. Christensen, Jr., Ph.D. (California at Santa Barbara); James N. Siedow, Ph.D. (Indiana).

### Lecturer

C. F. Culberson, Ph.D. (Duke).

Graduate work in the Department of Botany is offered leading to the A.M. (nonthesis), M.S. (thesis), and Ph.D. degrees. Before undertaking graduate study in botany a student should have had in the undergraduate program at least 12 semester hours of botany beyond an elementary course, and related work in biological sciences. Some work in chemistry and physics will be desirable and, for some phases of botanical study, a necessity. The student's graduate program is planned to provide a broad basic training in the various fields of botany, plus intensive specialization in the field of the research problem.

### Courses of Instruction

- |   |   |
|---|---|
| 203. Cytogenetics                           | 250L, S. Plant Biosystematics                                   |
| 203L. Cytogenetics (Laboratory)             | 251L. Plant Physiology  |
| 204L. Marine Microbiology                   | 253. Advanced Plant Physiology                                  |
| 206L. Anatomy of Woody Plants               | 256. Physiological Role of Minerals and Water                   |
| 207L. Microclimatology                      | 257S. Principles of Plant Distribution                          |
| 209L. Lichenology                           | 258. Physiology of Growth and Development                       |
| 210L. Bryology                              | 260L. Plant Anatomy   |
| 211L. Marine Phycology                      | 261. Photosynthesis   |
| 212L. Phycology                             | 265L. Physiological Plant Ecology                               |
| 214L. Biological Oceanography               | 267L. Plant Community Ecology                                   |
| 217L. Environmental Instrumentation         | 280. Principles of Genetics                                     |
| 221L. Mycology                              | 280L. Principles of Genetics (Laboratory)                       |
| 225T, 226T. Special Problems                | 285S. Population Genetics                                       |
| 233L. Microbiology                          | 286. Evolutionary Mechanisms                                    |
| 235. Evolutionary Systematics               | 287S. Quantitative Genetics                                     |
| 235L. Evolutionary Systematics (Laboratory) | 295S, 296S. Seminar   |
| 236S. Major Global Ecosystems               | 300. Tropical Biology: An Ecological Approach                   |
| 242L. Systematics                           | 305. Tropical Studies   |
| 245L. Plant Diversity                       | 344S. Advanced Topics in Micrometeorology and<br>Biometeorology |
| 246L. Ecology of Plants                     | 359-360. Research in Botany                                     |
| 248. Introductory Biochemistry              |   |

## Business Administration

### Professors

Helmy Baligh, Ph.D. (California at Berkeley); Kalman J. Cohen, Ph.D. (Carnegie-Mellon); Thomas

F. Keller, Ph.D. (Michigan), *R. J. Reynolds Industries Professor of Business Administration*; Dan J. Laughhunn, D.B.A. (Illinois); Arie Y. Lewin, Ph.D. (Carnegie-Mellon); David W. Peterson, Ph.D. (Stanford), *Director of Graduate Studies*.

#### Associate Professors

A. Rashad Abdel-Khalik, Ph.D. (Illinois); Kenneth R. Baker, Ph.D. (Cornell); Joseph Battle, Ph.D. (Michigan); Richard M. Burton, D.B.A. (Illinois); David C. Dellinger, Ph.D. (Stanford); John S. Hughes, Ph.D. (Purdue); Wayne J. Morse, Ph.D. (Michigan State).

#### Assistant Professors

William W. Damon, Ph.D. (Cornell); Mark R. Eaker, M.B.A., Ph.D. (Stanford); Jose A. Espejo, Ph.D. (Columbia); Lawrence Kessler, M.B.A. (California at Berkeley); Arthur J. Kuhn, Ph.D. (California at Berkeley); Wesley A. Magat, Ph.D. (Northwestern); Steven F. Maier, Ph.D. (Stanford); James H. Scheiner, Ph.D. (Ohio State); Robert E. Taylor, Ph.D. (North Carolina at Chapel Hill); James H. Vander Weide, Ph.D. (Northwestern); Robert A. Westbrook, Ph.D. (Michigan); Julie H. Zalkind, Ph.D. (Johns Hopkins).

The Graduate School of Business Administration offers work leading to the M.B.A., M.M., and Ph.D. The programs of study leading to the first two degrees are described in the *Bulletin of the Graduate School of Business Administration*. The Ph.D. program is designed for students who desire to enter either the academic profession or advanced and specialized administrative research positions. The program accepts students with bachelor's degree preparation and normally requires three to four years.

One year of study (30 units) beyond completion of the Duke M.B.A. degree or its equivalent is planned for each doctoral candidate. The year of study should include two courses in advanced economic theory, two courses in mathematics or statistics, and three courses in an elected field of administration. The latter are individually designed and are offered on a tutorial basis to provide extensive reading in the historical and current literature.

The requirements of the Graduate School are applicable to students in the Ph.D. program in business administration.

Management Science courses open only to students in Health Administration are listed under the Department of Health Administration.

#### Courses of Instruction

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|---|--|
| 301. Managerial Economics II                                  | 355. Financial Strategy                      |
| 309.1-.9. Research in Managerial Economics                    | 356. Finance                                 |
| 312. Operations Research                                      | 359.1-.9. Research in Finance                |
| 313. Advanced Operations Research                             | 365. Market Strategy                         |
| 319.1-.9. Research in Quantitative Methods                    | 366. Marketing                               |
| 320-321. Organization Theory and Management I, II             | 369.1-.9. Research in Marketing              |
| 329.1-.9. Research in Organization Theory and Management      | 375. Operations Strategy                     |
| 333. Controllership   | 376. Production                              |
| 334. External Reporting and Auditing                          | 379.1-.9. Research in Production             |
| 335. Management Information and Control Systems               | 381. Management of Financial Institutions    |
| 339.1-.9. Research in Information and Accounting Systems      | 382. Multinational Enterprise                |
| 345. Legal Environment of the Firm                            | 385. Strategy of the Organization I          |
| 346. Public Policy of the Firm                                | 386. Strategy of the Organization II         |
| 349.1-.9. Research in Public Policy and Social Responsibility | 390. The Practicum                           |
|   | 391.1-.9. Special Topics in Management       |
|   | 392-393. Tutorial in Interdisciplinary Areas |
|   | 397. Dissertation Research                   |

## Chemistry

#### Professors

Charles Kilgo Bradsher, Ph.D. (Harvard), *James B. Duke Professor of Chemistry*; Donald B. Chesnut, Ph.D. (California Inst. of Tech.); Marcus Edwin Hobbs, Ph.D. (Duke); Peter W. Jeffs, Ph.D. (Natal), *Director of Graduate Studies*; William R. Krigbaum, Ph.D. (Illinois), *James B. Duke Professor of Chemistry and Chairman*; Andrew T. McPhail, Ph.D. (Glasgow); Jacques C. Poirier, Ph.D. (Chicago); Louis

DuBose Quin, Ph.D. (North Carolina at Chapel Hill); Peter Smith, Ph.D. (Cambridge); Howard Austin Strobel, Ph.D. (Brown); Richard L. Wells, Ph.D. (Indiana); Pelham Wilder, Jr., Ph.D. (Harvard).

#### Associate Professors

Steven Baldwin, Ph.D. (California Inst. of Tech.); Alvin L. Crumbliss, Ph.D. (Northwestern); Robert W. Henkens, Ph.D. (Yale); Charles H. Lochmüller, Ph.D. (Fordham); Richard A. Palmer, Ph.D. (Illinois); Ned Allen Porter, Ph.D. (Harvard).

#### Assistant Professors

Rodger W. Baier, Ph.D. (Washington); William Gutknecht, Ph.D. (Purdue); William L. Luken, Jr., Ph.D. (Yale); Robert H. Neilson, Ph.D. (Duke); Barbara R. Shaw, Ph.D. (Washington).

#### Adjunct Associate Professors

Robert G. Ghirardelli, Ph.D. (California Inst. of Tech.); Colin G. Pitt, Ph.D. (London); David Rosenthal, Ph.D. (Massachusetts Inst. of Tech.); Bernard F. Spielvogel, Ph.D. (Michigan).

In the Department of Chemistry graduate work is offered leading to the A.M. and Ph.D. degrees. Before undertaking a graduate program in chemistry, a student should have taken an undergraduate major in chemistry, along with related work in mathematics and physics.

Graduate courses in the department are offered in the fields of analytical, inorganic, organic, and physical chemistry. Research programs are active in all these fields.

A booklet providing detailed information on the department is available from the Director of Graduate Studies.

#### Courses of Instruction

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|--|---|
| 201. Molecular Spectroscopy                                  | 313, 314. Special Topics in Inorganic Chemistry                       |
| 203. Quantum Chemistry                                       | 320. Synthetic Organic Chemistry                                      |
| 205. Structure and Reaction Dynamics                         | 322. Organic Reactive Intermediates                                   |
| 207. Principles of Thermodynamics, Diffraction, and Kinetics | 323, 324. Special Topics in Organic Chemistry                         |
| 230. Environmental Oceanography                              | 330. Chemical Separation Methods and Kinetics in Analytical Chemistry |
| 240. Chemical Oceanography                                   | 331, 332. Special Topics in Analytical Chemistry                      |
| 275, 276. Advanced Studies                                   | 334. Chemical Instrumentation and Applied Spectroscopy                |
| 300. Basic Statistical Mechanics                             | 373, 374. Seminar   |
| 302. Basic Quantum Mechanics                                 | 375, 376. Research  |
| 303, 304. Special Topics in Physical Chemistry               | 377. Research Orientation Seminar                                     |
| 310. Theoretical and Structural Inorganic Chemistry          |   |
| 312. Inorganic Reactions and Mechanisms                      |   |

## Classical Studies

#### Professors

Francis Newton, Ph.D. (North Carolina at Chapel Hill), *Director of Graduate Studies*; John F. Oates, Ph.D. (Yale), *Chairman*; Lawrence Richardson, Jr., Ph.D. (Yale), F.A.A.R.; William H. Willis, Ph.D. (Yale).

#### Associate Professor

Dennis Keith Stanley, Jr., Ph.D. (Johns Hopkins).

#### Assistant Professors

Peter H. Burian, Ph.D. (Princeton); Kent J. Rigsby, Society of Fellows (Harvard).

#### Visiting Lecturer

Harry L. Levy, Ph.D. (Columbia).

The Department of Classical Studies offers two programs leading to the Ph.D. degree, one with emphasis on literature and philology, the other with emphasis on ancient history and archeology. For regular admission to the program in literature and philology, a student must offer three years of college study above the elementary level in one of the classical lan-

guages and two college years in the other. Students wishing to enter the program in ancient history and archeology will be required on entrance to demonstrate satisfactory competence in both Greek and Latin for reading in the primary sources; failure to demonstrate such competence will require modification of the student's program to repair the deficiency.

The department's special requirements, in addition to the general requirements of the University for the Ph.D. degree set forth in the section on Program Information in the detailed *Bulletin of the Graduate School*, are presented in a sheet that may be obtained from the Director of Graduate Studies. They include special requirements in seminars, course work, and the preliminary examination for the Ph.D. degree.

A reading knowledge of German and French is required of all candidates for the Ph.D. degree. The candidate should meet one of the language requirements by the end of the first term in residence and the other by the end of the third term.

#### GREEK

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|-------------------------|------------------------------------|
| 200. Graduate Reading   | 241. Advanced Prose Composition    |
| 203. Homer              | 301. Greek Seminar I               |
| 205. Greek Lyric Poets  | 302. Greek Seminar II              |
| 206. Aeschylus          | 303. Greek Seminar III             |
| 208. Sophocles          | 304. Greek Seminar IV              |
| 209. Euripides          | 305. Greek Seminar V               |
| 210. Aristophanes       | 306. Greek Seminar VI              |
| 221. Early Greek Prose  | 311. Proseminar in Papyrology      |
| 222. Thucydides         | 313. Proseminar in Greek Epigraphy |
| 223. Greek Orators I    | 321. Seminar in Literary Papyri    |
| 224. Greek Orators II   | 323. Seminar in Documentary Papyri |
| 225. Plato              | 399. Directed Reading and Research |
| 231. Hellenistic Poetry |                                    |

#### LATIN

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|----------------------------------|--------------------------------------|
| 200. Graduate Reading            | 225. Latin Paleography               |
| 201. The Verse Treatise          | 241. Advanced Latin Composition      |
| 202. Roman Satire                | 250. Teaching Latin                  |
| 203. Epic: Vergil                | 301. Latin Seminar I                 |
| 204. Epic: Lucan and Statius     | 302. Latin Seminar II                |
| 207. The Prose Epistle           | 303. Latin Seminar III               |
| 208. The Epistle in Verse        | 304. Latin Seminar IV                |
| 209. Fragments of Early Latin    | 305. Latin Seminar V                 |
| 210. Lyric and Occasional Poetry | 306. Latin Seminar VI                |
| 211. Roman Oratory I             | 312. Proseminar in Latin Paleography |
| 212. Roman Oratory II            | 314. Proseminar in Latin Epigraphy   |
| 221. Medieval Latin I            | 315. Proseminar in Roman Law         |
| 222. Medieval Latin II           | 399. Directed Reading and Research   |

#### CLASSICAL STUDIES

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|--|-------------------------------|
| 301. Introduction to Classical Philology | 351. The Teaching of Classics |
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#### CLASSICAL STUDIES (ANCIENT HISTORY)

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|--|--|
| 253. Greece to the Orientalizing Period  | 263. From the Flavian Dynasty to the Severan |
| 254. The Age of the Tyrants and the Persian Wars                                     | 264. From Septimius Severus to Constantine   |
| 255. The Age of Pericles   | 270. The Rise of the Hellenistic Kingdoms    |
| 256. The Fourth Century through Alexander  | 271. The Hellenistic World, 250-31 B.C.      |
| 257. Social and Cultural History of the Hellenistic World from Alexander to Augustus | 321. Seminar in Ancient History I            |
| 258. Social and Cultural History of the Graeco-Roman World                           | 322. Seminar in Ancient History II           |
| 260. The History of Rome to 146 B.C.   | 323. Seminar in Ancient History III          |
| 261. The Roman Revolution, 146-30 B.C.   | 324. Seminar in Ancient History IV           |
| 262. Rome under the Julio-Claudians  | 325. Seminar in Ancient History V            |
|  | 326. Seminar in Ancient History VI           |
|  | 327. Seminar in Byzantine History            |
|  | 399. Directed Reading and Research           |



## CLASSICAL STUDIES (ARCHEOLOGY)

231S. Greek Sculpture  
232S. Greek Painting  
235S. Roman Architecture

236S. Roman Painting  
311. Archeology Seminar I  
312. Archeology Seminar II

## Comparative Literature

No graduate degree is offered in comparative literature. The following courses may serve, however, in the minor programs of students in other departments. Consult Professor Wardropper in the Department of Romance Languages.

### Courses of Instruction

220S. Comparative Literature Seminar

280. Criticism

## Computer Science

### Professors

Thomas M. Gallie, Ph.D. (Rice); Donald W. Loveland, Ph.D. (New York Univ.), *Chairman*; Peter N. Marinos, Ph.D. (North Carolina State); Thomas H. Naylor, Ph.D. (Tulane); Max A. Woodbury, Ph.D. (Michigan).

### Associate Professors

William E. Hammond, Ph.D. (Duke); Merrell L. Patrick, Ph.D. (Carnegie Inst. of Tech.); Charles Starmer, Ph.D. (North Carolina at Chapel Hill).

### Assistant Professors

Alan W. Biermann, Ph.D. (California at Berkeley); Edmund M. Clarke, Jr., Ph.D. (Cornell); Derrell V. Foster, Ph.D. (Texas at Austin); Susan L. Gerhart, Ph.D. (Carnegie-Mellon), *Director of Graduate Studies*; Dietolf Ramm, Ph.D. (Duke); Kishor S. Trivedi, Ph.D. (Illinois).

### Adjunct Associate Professor

Leland Williams, Ph.D. (Duke).

The Department of Computer Science offers programs leading to the A.M. and Ph.D. degrees.

A student entering graduate work in computer science should have a knowledge of mathematics through advanced calculus and of at least two computer programming languages. Research interests of present faculty include mathematical foundations of computer science, artificial intelligence, program verification, programming languages, real-time computing, operating systems, information storage and retrieval, computer design, simulation of systems of interest to social scientists, and numerical analysis.

### Courses of Instruction

200. Programming Methodology  
201. Programming Languages  
208. Digital Computer Design  
215. Artificial Intelligence  
221. Numerical Analysis I  
222. Numerical Analysis II  
223. Numerical Optimization  
225. Mathematical Foundations of Computer Science I  
226. Mathematical Foundations of Computer Science II  
231. Introduction to Operating Systems  
232. Metaprograms  
241. Data Base Management Systems

244. Computer Simulation Models of Economic Systems  
250. Clustering and Classification  
251. Computer Science for Teachers  
252. Computer Systems Organization  
265. Advanced Topics in Computer Science  
301. Topics in Programming Theory  
307. Advanced Digital Systems I  
308. Advanced Digital Systems II  
315. Advanced Artificial Intelligence  
321. Topics in Numerical Mathematics  
325. Theory of Computation  
326. Systems Modeling

331. Operating Systems Theory  
332. Topics in Operating Systems

344. Workshop on Computer Models of Social Systems

## Economics

### Professors

John Oliver Blackburn, Ph.D. (Florida), C.P.A.; Martin Bronfenbrenner, Ph.D. (Chicago), *William R. Kenan, Jr. Professor of Economics*; David George Davies, Ph.D. (California at Los Angeles); Craufurd David Goodwin, Ph.D. (Duke); Henry Grabowski, Ph.D. (Princeton); Allen C. Kelley, Ph.D. (Stanford), *Chairman*; Juanita Morris Kreps, Ph.D. (Duke), *James B. Duke Professor of Economics*; Harold Gregg Lewis, Ph.D. (Chicago); Thomas Herbert Naylor, Ph.D. (Tulane); Lloyd Blackstone Saville, Ph.D. (Columbia); Vladimir G. Trembl, Ph.D. (North Carolina at Chapel Hill); John M. Vernon, Ph.D. (Massachusetts Inst. of Tech.); Thomas D. Wallace, Ph.D. (Chicago); Eliot Roy Weintraub, Ph.D. (Pennsylvania), *Director of Graduate Studies*; William Poe Yohe, Ph.D. (Michigan).

### Associate Professors

Neil de Marchi, Ph.D. (Australian National Univ.); Daniel A. Graham, Ph.D. (Duke); Thomas M. Havrilesky, Ph.D. (Illinois); Marjorie McElroy, Ph.D. (Northwestern); Edward Tower, Ph.D. (Harvard).

### Assistant Professors

Bruce R. Bolnick, Ph.D. (Yale); Philip J. Cook, Ph.D. (California at Berkeley); Joseph Lipscomb, Jr., Ph.D. (North Carolina at Chapel Hill); John A. Weymark, A.M. (Pennsylvania); Allen M. Wyse, Ph.D. (Illinois).

The Department of Economics offers graduate work leading to the A.M. and Ph.D. degrees. Among the undergraduate courses of distinct advantage to the graduate student in economics are statistics, economic theory, and basic courses in philosophy, mathematics, and social sciences other than economics. Advanced work in mathematics or statistics is also useful.

Requirements for the Ph.D. degree in economics include examination in economic theory at the end of the first year, and, at the end of the second year, an examination in economic analysis. In addition a student must obtain certification in three fields, one of which may be in an outside minor. The student may select from advanced economic theory, history of political economy, economic development, economic history, international economics, money and banking, labor economics, public finance, industrial organization, econometrics, statistics, Soviet economics, and certain fields outside the economics department (e.g., demography). Course work for the Ph.D. degree should be completed in four semesters of residence.

### Courses of Instruction

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|---|---|
| 200. Capitalism and Socialism                       | 503. Theory of Economic Decision-making                                   |
| 204S. Advanced Money and Banking                    | 304, 305. Monetary Theory and Policy                                      |
| 231S. Economic Development of Europe                | 307. Quantitative Analysis I  |
| 232. Economic History of Japan                      | 308. Quantitative Analysis II   |
| 233. State and Urban Finance*                       | 311, 312. History of Political Economy                                    |
| 237, 238. Statistical Methods                       | 313, 314. Seminar in Economic Theory                                      |
| 243. Econometrics I                                 | 316. Seminar in Economics of Soviet-Type Socialism                        |
| 244. Computer Simulation Models of Economic Systems | 317. Seminar in Demographic, Population, and Resource Problems            |
| 245. Econometrics II                                | 318. Dissertation Seminar   |
| 257. Manpower and Human Resources                   | 319. Seminar in the Theory and the Problems of Economic Growth and Change |
| 262. Trade Unionism and Collective Bargaining       | 320. Macroeconomic Analysis I   |
| 265S. International Trade and Finance               | 321. Theory of Quantitative Economic Policy                               |
| 287. Public Finance                                 | 322. Macroeconomic Analysis II  |
| 293. Soviet Economic History                        | 323. Income Distribution Theory   |
| 294S. Soviet Economic System                        |   |
| 301. Microeconomic Analysis I                       |   |
| 302. Microeconomic Analysis II                      |   |

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\*Offered on demand.

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|--|--|
| 329. Federal Finance                               | 365. Seminar in International Trade Theory                           |
| 330. Seminar in Public Finance                     | 366. Seminar in International Monetary Theory                        |
| 331. Seminar in Economic History                   | 388. Industrial Organization*  |
| 344. Workshop on Computer Models of Social Systems | 389. Seminar in Industrial and Governmental Problems*                |
| 345, 346. Demographic Techniques I and II          | 397, 398. Directed Research  |
| 350. Seminar in Applied Economics                  | 401. Seminar on the British Commonwealth                             |
| 355. Seminar in Labor Economics                    | 402. Interdisciplinary Seminar in the History of the Social Sciences |
| 358. Seminar in Labor Market and Related Analysis  |  |

## Education

### Professors

Anne H. Adams, Ed.D. (Mississippi); William H. Cartwright, Ph.D. (Minnesota); Anne Flowers, Ed.D. (Duke), *Chairman*; W. Scott Gehman, Jr., Ph.D. (Pennsylvania State); Sherwood Githens, Jr., Ph.D. (North Carolina at Chapel Hill); Everett H. Hopkins, A.M. (Pennsylvania), LL.D.; Allan S. Hurlburt, Ph.D. (Cornell); William G. Katzenmeyer, Ed.D. (Duke); Olan Lee Petty, Ph.D. (Iowa), *Director of Graduate Studies*; R. Baird Shuman, Ph.D. (Pennsylvania); Henry Weitz, Ed.D. (Rutgers).

### Associate Professors

Robert H. Ballantyne, Ed.D. (Washington State); Peter F. Carbone, Ed.D. (Harvard); Robert Merle Colver, Ed.D. (Kansas); Lucy T. Davis, Ed.D. (Columbia); Joseph DiBona, Ph.D. (California at Berkeley); Charles B. Johnson, Ed.D. (Duke); David V. Martin, Ed.D. (Duke); Robert A. Pittillo, Jr., Ed.D. (Duke); Robert N. Sawyer, Ed.D. (Wyoming).

### Assistant Professor

Stephen F. Lehane, Ed.D. (Columbia).

### Lecturers

John A. Fowler, M.D. (Bowman Gray); Ila Gehman, Ed.D. (Pennsylvania State); Richard H. Leach, Ph.D. (Princeton); Paul D. Williams, Ph.D. (Duke).

Graduate work in education is offered leading to the A.M., the M.Ed., the M.A.T., the Ed.D., and the Ph.D. degrees. For each of these degrees there are specific requirements and prerequisites, all of which may be found stated in the detailed *Bulletin of the Graduate School*. Departmental requirements and prerequisites for all of these degrees may be obtained from the Director of Graduate Studies.

From the courses listed below, plus several in related disciplines, a selection may be made which will meet North Carolina requirements for the Advanced Principal's Certificate, the Superintendent's Certificate, and the Supervisor's Certificate.

(Some courses below are offered only in the summer session; see the *Bulletin of the Summer Session*.)

These programs are accredited by the National Council for Accreditation of Teacher Education for the preparation of elementary and secondary school teachers and school service personnel with the doctor's degree as the highest degree approved.

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|--|--|
| 201. Mathematics Program in the Elementary School                    | 213. Elementary School Organization and Administration             |
| 202. Comparative and International Education: Industrialized Nations | 215. Secondary Education: Principles                               |
| 203. Seminar in Philosophical Analysis of Educational Concepts       | 216. Secondary Education: Internship                               |
| 204. Educational Organization  | 217. The Psychological Principles of Education                     |
| 206. Studies in the History of Educational Philosophy                | 218. Comparative and International Education: Developing Societies |
| 207. Social History of Twentieth-Century American Education          | 219. Comparative and International Education: South Asia           |
| 209. John Dewey  | 221. Programs in Early Childhood Education                         |
| 210. The Politics of Education                                       | 222. New Developments in Elementary School Curriculum              |
|  | 223. Teaching the Language Arts                                    |

\*Offered on demand.

224. Teaching the Social Studies in Elementary Schools
225. The Teaching of History and the Social Studies
226. Teaching Developmental and Remedial Reading in the Elementary School
229. Assessments of Reading Disability Cases
230. Research Methodology in Education
232. Psychoeducational Counseling with Parents
233. Improvement of Instruction in English
234. Secondary School Organization and Administration
236. Teaching Developmental and Remedial Reading in the Secondary School
237. Teaching of Literature in Secondary Schools
238. Content, Supervision, and Administration of Reading Programs
239. Teaching of Grammar, Composition, Mechanics, and Usage in Secondary School
240. Career Development
241. Foundations of Counseling and Personnel Services
243. Personality Dynamics
244. Counseling Techniques
245. Theories of Counseling
246. Teaching of Mathematics
247. Practicum in Guidance and Counseling
248. Practicum in Counseling
249. Exceptional Children
- 250, 251. Teaching Emotionally Disturbed Children: Internship
253. Introduction to Law and Education
254. Law and Higher Education
255. Assessment of Abilities
256. Classroom Assessment of Student Achievement
258. Assessment of Personality, Interests, and Attitudes
259. Problems in Law and Education
260. Educational Research I
261. Educational Research II
262. Educational Research III
266. Basic Science for Teachers
268. Seminar in Contemporary Educational Criticism
270. Junior and Community College
271. Instructional Systems for College and University Teaching
272. Teaching Communication Skills in Early Childhood Education
- 273, 274. Clinical Reading Practicum
276. The Teaching of High School Science
285. Audiovisual Aids in Education
291. Public and Community Relations of Schools
300. Individual Assessment of Intelligence
301. Advanced Individual Assessment of Cognitive Abilities
302. Seminar in Educational Research
303. Diagnostic and Educational Programs in Learning Disabilities
304. Internship in School Psychology
309. Seminar on Higher Education in the United States
310. Seminar in Higher Educational Administration
311. Group Counseling
313. Seminar in Education and Public Policy
314. Seminar in Guidance and Counseling
315. Seminar in Secondary School Teaching
- 316, 317. Practicum in Higher Educational Research and Development
321. Educational Management
322. Planning and Management of Educational Facilities
323. Public School Finance
326. Educational Psychology: The Problem Child
332. Supervision of Instruction
- 335, 336. Seminar in School Administration
337. Seminar in Community College Organization
338. Seminar in Educational Supervision
339. Seminar in Curriculum
340. Seminar in Social Studies Curriculum
341. Seminar in Elementary School Curriculum
342. Seminar in Secondary School Curriculum
343. History of Higher Education in America
344. Research in Higher Education
345. Seminar in Reading Instruction and Research
346. Seminar in Organization of Pre-Service and In-Service Reading Programs
347. Student Personnel Services in Higher Education
- 348, 349. Seminar in Child Psychopathology
- 350, 351. Directed Activities in Education
360. Seminar on Instructional Strategies

## Engineering

The School of Engineering offers programs of study and research leading to the degrees of Master of Science and Doctor of Philosophy with a major in biomedical, civil, or electrical engineering, or in mechanical engineering and materials science. These programs are designed to provide a fundamental understanding of the engineering sciences, which are based on mathematics and the physical sciences, and to develop experience in the art of engineering, which includes strong elements of intuition, imagination, and judgment. Engineering graduate students may participate in seminars appropriate to their fields of study.

A *minimum* of 30 units of earned graduate credit beyond the bachelor's degree is required for the M.S. degree: 12 in the major, 6 in related minor work (usually mathematics or natural science), 6 in either the major or minor subject or in other areas approved by the major department, and 6 for a research-based thesis. A non-thesis option requiring 30 units



of course credit is available. Each of the departments imposes additional requirements in the exercise of this option. There is no language requirement for this degree.

A *minimum* of 60 units of earned graduate credit beyond the bachelor's degree is required for the Ph.D. degree. In civil and electrical engineering, 24 units are required in the major field and 12 units in a related minor field (often mathematics or natural science), 12 in either the major or minor subject or other areas approved by the major department and 12 for a research-based dissertation. In biomedical and mechanical engineering there are no specific course requirements; each program is planned to meet individual needs. Doctoral students are required to pass qualifying and preliminary examinations which may be either written, oral, or a combination of written and oral components, at the discretion of the committee and the department.

## BIOMEDICAL ENGINEERING

### Professors

Howard G. Clark, Ph.D. (Maryland); James M. McElhaney, Ph.D. (West Virginia); Loren Nolte, Ph.D. (Michigan); Theo Clyde Pilkington, Ph.D. (Duke), *Chairman*; Frederick L. Thurstone, Ph.D. (North Carolina State), *Director of Graduate Studies*; Myron Wolbarsht, Ph.D. (Johns Hopkins).

### Associate Professors

Roger Barr, Ph.D. (Duke); Evan A. Evans, Ph.D. (California at San Diego); William E. Hammond, Ph.D. (Duke); Howard C. Wachtel, Ph.D. (New York Univ.).

### Assistant Professors

H. Dennis Tolley, Ph.D. (North Carolina at Chapel Hill); Olaf T. von Ramm, Ph.D. (Duke).

Biomedical engineering is often defined as the application of the concepts and methods of the physical, mathematical, and engineering sciences to biology and medicine. The definition covers a broad spectrum ranging from formalized mathematical theory through experimental science to practical clinical applications. The purpose of the graduate program in biomedical engineering is to encourage the optimum combining of engineering and biomedical course work with an interdisciplinary research topic so that the graduates of this program can contribute at the most advanced professional level to the interdisciplinary field of biomedical engineering. The major research areas available include: biomechanics, biomedical materials; biomedical modeling; data acquisition and processing; and electrophysiology.

### Courses of Instruction

201. Analysis of Bioelectric Phenomena	241, 242. Information Organization and Retrieval
202. Energy and Rate in Biological Processes	243. Computers in Biomedical Engineering
203. Bioelectric Potentials and Field Theory	252. Marine Electrobiology
204. Real Time Measurement and Control of Heart Events	265. Advanced Topics in Biomedical Engineering
207. Experimental Mechanics	311. Inverse Models
223. Biomedical Materials and Artificial Organs	333. Biomedical Imaging
225. Mechanics of Cellular Components	399. Special Readings in Biomedical Engineering
230. Biomechanics	
233. Discrete Systems and Models of Computation	

## CIVIL ENGINEERING

### Professors

Earl I. Brown, Ph.D. (Texas), *J. A. Jones Professor of Civil Engineering*; J. Dvorak, Ph.D. (Brown), *Director of Graduate Studies*; Bruce J. Muga, Ph.D. (Illinois), *Chairman*; Senol Utku, Sc.D. (Massachusetts Inst. of Tech.); Aleksandar Sedmak Vesić, D.Sc. (Belgrade), *J. A. Jones Professor of Civil Engineering*.

### Associate Professors

Aubrey E. Palmer, B.S.C.E. (Virginia); P. Aarne Vesilind, Ph.D. (North Carolina at Chapel Hill); James F. Wilson, Ph.D. (Ohio State).

## Assistant Professors

Miguel A. Medina, Jr., M.S. (Alabama); Yuet Tsui, Ph.D. (Duke).

## Adjunct Professor

Edward A. Saibel, Ph.D. (Massachusetts Inst. of Tech.).

## Adjunct Assistant Professor

Dennis Warner, Ph.D. (Stanford).

## Lecturers

Donald E. Francisco, Ph.D. (North Carolina at Chapel Hill); Gorman Gilbert, Ph.D. (Northwestern); George T. Lathrop, M.C.P. (Yale).

A student may specialize in one of the following fields of study for either the M.S. or the Ph.D. degree: environmental engineering; geotechnical engineering and soil mechanics; mechanics of solids; materials engineering; fluid mechanics, water resources, and ocean engineering; structural engineering; and urban systems and transportation. Interdisciplinary programs combining study in some of the major areas with biological sciences, business administration, materials science, social sciences, political science, and other areas of engineering are also available. In addition, there is a special program leading to the M.S. degree in civil engineering and the A.M. degree in public policy sciences.

With the approval of the department, a master's degree candidate in civil engineering may choose, in lieu of submitting a thesis, to complete an additional 6 units of course work plus a special project. If this alternative is elected, candidates are expected to take comprehensive examinations over their graduate course work, and also to defend orally their special projects.

Under the Reciprocal Agreement with Neighboring Universities, a student may include as a portion of the minimum requirements work offered by the Department of Environmental Sciences and Engineering of the University of North Carolina. Although related work normally is taken in the natural sciences or mathematics, a student whose major interest relates to the social or managerial sciences may take relevant work in these areas.

A minimum prerequisite to the graduate program in civil engineering is a basic knowledge of mathematics through linear differential equations, materials science, solid mechanics, and fluid mechanics.

## Courses of Instruction

- |  |   |
|--|---|
| 201. Advanced Mechanics of Solids                | 236. Earth Structures   |
| 204. Plates and Shells                           | 238. Rock Mechanics   |
| 205. Elasticity                                  | 241. Environmental Engineering Chemistry and Biology              |
| 206. Advanced Mechanics of Solids II             | 243, 244. Sanitary Engineering Unit Operations and Process Design |
| 209. Structural Dynamics                         | 246. Sanitary Engineering Design                                  |
| 210. Intermediate Dynamics                       | 247. Air Pollution Control  |
| 212. Mechanical Behavior of Materials            | 248. Solid Waste and Resource Recovery Engineering                |
| 215. Urban and Regional Geography                | 249. Resource Recovery Systems Management                         |
| 216. Transportation Planning and Policy Analysis | 250. Engineering Analysis   |
| 217. Transportation Systems Analysis             | 251. Systematic Structural Analysis I                             |
| 218. Engineering-Economic Analysis               | 252. Systematic Structural Analysis II                            |
| 221. Incompressible Fluid Flow                   | 306. Plasticity   |
| 222. Open Channel Flow                           | 331. Special Problems of Systematic Analysis                      |
| 223. Flow Through Porous Media                   | 335. Mechanical Behavior of Soils                                 |
| 224. Coastal and Offshore Engineering            | 336. Advanced Soil Mechanics                                      |
| 225. Engineering Hydrology                       | 337. Elements of Soil Dynamics                                    |
| 231. Structural Engineering Analysis             | 350. Advanced Engineering Analysis                                |
| 232. Reinforced Concrete Design                  | 365. Advanced Topics in Civil Engineering                         |
| 233. Prestressed Concrete Design                 | 399. Special Readings in Civil Engineering                        |
| 234. Structural Design in Metals                 |   |
| 235. Foundation Engineering                      |   |

## ELECTRICAL ENGINEERING

### Professors

John Leslie Artley, D.Eng. (Johns Hopkins); Robert Blackburn Kerr, Ph.D. (Johns Hopkins); Peter N. Marinos, Ph.D. (North Carolina State), *Director of Graduate Studies*; Loren W. Nolte, Ph.D. (Michigan); Harry Ashton Owen, Jr., Ph.D. (North Carolina State); Theo Clyde Pilkington, Ph.D. (Duke); Frederick L. Thurstone, Ph.D. (North Carolina State); Paul P. Wang, Ph.D. (Ohio State); Thomas George Wilson, Sc.D. (Harvard).

### Associate Professors

Herbert Hacker, Ph.D. (Michigan), *Chairman*; William Thomas Joines, Ph.D. (Duke).

### Assistant Professors

Rhett Truesdale George, Jr., Ph.D. (Florida); Richard Shubert, Ph.D. (Washington).

A student may specialize in any one of the following fields in working toward either the M.S. or the Ph.D. degree with a major in electrical engineering: solid state materials and devices; ferromagnetics; optical electronics and lasers; instrumentation; electronic systems; microwaves; control theory; energy conversion; digital systems; stochastic systems; and information processing.

Recommended prerequisites for the graduate courses in electrical engineering include a knowledge of basic mathematics and physics, electric networks, and systems theory. Students in doubt about their background for enrollment in specific courses should discuss the matter with the Director of Graduate Studies. The M.S. degree program includes either a thesis or an oral comprehensive examination. A qualifying examination is required for the Ph.D. degree program. These examinations are intended to test both the breadth and depth of the student's understanding of electrical engineering. There is no foreign language requirement.

### Courses of Instruction

- |   |   |
|---|---|
| 203. Random Signals and Noise                                   | 251. Pattern Classification and Recognition               |
| 204. Information Theory and Communication Systems               | 265. Advanced Topics in Electrical Engineering            |
| 205. Signal Detection and Extraction Theory                     | 266. Biofeedback Systems                                  |
| 206. Digital Signal Processing                                  | 271. Electromagnetic Theory                               |
| 208. Digital Computer Design                                    | 272. Application of Electromagnetic Theory                |
| 211. Solid State Theory   | 297-298. Thesis Research                                  |
| 212. Solid State Materials                                      | 304. Estimation, Filtering, and Random Systems            |
| 213. Principles of Magnetism                                    | 305. Advanced Applications of Statistical Decision Theory |
| 215. Semiconductor Physics                                      | 306. Adaptive Detection and Communication Systems         |
| 217. Masers   | 307. Advanced Digital Systems I                           |
| 221. Nonlinear Networks and Systems                             | 308. Advanced Digital Systems II                          |
| 222. Nonlinear Analysis   | 313. Magnetic Processes in Materials*                     |
| 224. Integrated Electronics: Analog and Digital                 | 317. Quantum Electronics                                  |
| 225. Semiconductor Electronic Circuits                          | 321. Nonlinear Magnetic and Semiconductor Circuits        |
| 226. Modeling and Computer-Aided Analysis of Electronic Systems | 324. Nonlinear Oscillations in Physical Systems           |
| 227. Network Synthesis  | 342. Optimal Control Theory                               |
| 231. Energy Systems   | 371. Advanced Electromagnetic Theory*                     |
| 241. Linear Systems   | 373. Selected Topics in Field Theory*                     |
| 242. Modern Control and Dynamic Systems                         | 399. Special Readings in Electrical Engineering           |
| 243. Advanced Linear Systems Theory                             |   |

## MECHANICAL ENGINEERING AND MATERIALS SCIENCE

### Professors

Jack Bartley Chaddock, Sc.D. (Massachusetts Inst. of Tech.), *Chairman*; Howard G. Clark, Ph.D. (Maryland); Franklin H. Cocks, Sc.D. (Massachusetts Inst. of Tech.); Devendra P. Garg, Ph.D. (New York Univ.); Charles Morgan Harman, Ph.D. (Wisconsin); John Nelson Macduff, M.M.E. (New York Univ.); George Wilbur Pearsall, Sc.D. (Massachusetts Inst. of Tech.).

\*Offered on demand.

## Adjunct Professor

Verne L. Roberts, Ph.D. (Illinois).

## Associate Professors

Ernest Elsevier, M.S.M.E. (Georgia Inst. of Tech.); Marion LaVerne Shepard, Ph.D. (Iowa State); Donald Wright, Ph.D. (Purdue).

## Adjunct Associate Professor

George Mayer, Ph.D. (Massachusetts Inst. of Tech.).

## Assistant Professors

Gale Herbert Buzzard, Ph.D. (North Carolina State), *Director of Graduate Studies*; Charles E. Johnson, Ph.D. (Duke); Edward Shaughnessy, Jr., Ph.D. (Virginia).

Graduate study is available to students seeking the M.S. and Ph.D. degrees with a major in either mechanical engineering or materials science. Departmental programs of advanced study and research include control systems, dynamics and vibrations, energy conversion, fluid mechanics, heat and mass transport, mechanical design, thermodynamics, physical metallurgy, corrosion, fracture, and polymer science. The faculty cooperates with faculty members from a number of other departments and schools to establish interdisciplinary research projects and programs of study in areas which include applied mechanics, biomechanics, biomedical materials, environmental quality and control, interaction of fields and materials, ocean engineering, systems engineering, engineering and public policy, and transportation systems.

The program includes the opportunity for experimental work as well as theoretical study. A major emphasis is placed upon developing the research ability of the student and relating the program to the evolving needs of modern engineering practice.

## Courses of Instruction

- |   |  |
|---|--|
| 202. Engineering Thermodynamics                       | 251. Refrigeration and Cryogenics                |
| 209. Structural Dynamics                              | 265. Advanced Topics in Mechanical Engineering   |
| 210. Intermediate Dynamics                            | 273. Ocean (Mechanical) Engineering              |
| 211. Theoretical and Applied Polymer Science          | 280. Nuclear Reactor Power Cycles                |
| 213. Advanced Materials Science                       | 300. Advanced Projects in Mechanical Engineering |
| 214. Corrosion and Corrosion Control                  | 302. Advanced Thermodynamics                     |
| 216. Materials Design and Resource Conservation       | 311. Behavior of Crystalline Solids              |
| 221. Compressible Fluid Flow                          | 322. Mechanics of Viscous Fluids                 |
| 222. Heat Transfer                                    | 323. Convective Heat Transfer                    |
| 223. Principles and Design of Heat Transfer Equipment | 324. Conduction and Radiation Heat Transfer      |
| 224. An Introduction to Turbulence                    | 327. Homogeneous Turbulence                      |
| 226. Intermediate Fluid Mechanics                     | 328. Turbulent Shear Flow                        |
| 230. Modern Control and Dynamic Systems               | 331. Nonlinear Control Systems                   |
| 231. Systems Response and Control                     | 333. Seminar in Control Systems                  |
| 232. Nonlinear Analysis                               | 335. Analytical Methods in Vibrations            |
| 233. Fluid Control Systems                            | 372. Finite Element Techniques in Design         |
| 235. Advanced Mechanical Vibrations                   | 399. Special Readings in Mechanical Engineering  |
| 236. Engineering Acoustics and Noise Control          |  |

## English

### Professors

Carl Anderson, Ph.D. (Pennsylvania); Louis J. Budd, Ph.D. (Wisconsin), *Chairman*; Edwin H. Cady, Ph.D. (Wisconsin), *Andrew W. Mellon Professor in the Humanities*; Bernard I. Duffy, Ph.D. (Ohio State); Oliver W. Ferguson, Ph.D. (Illinois); Holger O. V. Nygard, Ph.D. (California at Berkeley), *Director of Graduate Studies*; Dale B. J. Randall, Ph.D. (Pennsylvania); Edmund Reiss, Ph.D. (Harvard); Clyde de Loache Ryals, Ph.D. (Pennsylvania); Grover C. Smith, Ph.D. (Columbia); Arlin Turner, Ph.D. (Texas); George W. Williams, Ph.D. (Virginia).



### Associate Professors

Ronald Richard Butters, Ph.D. (Iowa); A. Leigh DeNeef, Ph.D. (Pennsylvania State); Gerald E. Gerber, Ph.D. (Northwestern); Wallace Jackson, Ph.D. (Pennsylvania); Buford Jones, Ph.D. (Harvard); Elgin Mellow, Ph.D. (London); Gerald Monsman, Ph.D. (Johns Hopkins); Victor H. Strandberg, Ph.D. (Brown).

The department offers graduate work leading to the A.M., M.A.T., and Ph.D. degrees. A statement of the requirements for the A.M. and Ph.D. degrees may be obtained from the Director of Graduate Studies. The department requires a reading knowledge of one foreign language for the A.M. degree; for the Ph.D. degree, two languages determined by the student's committee.

### Courses of Instruction

- |   |   |
|---|---|
| 207. Old English Grammar and Readings           | 318. Medieval Romances                          |
| 208. History of the English Language            | 320. Studies in Renaissance English Prose       |
| 209. Present-Day English                        | 324. Studies in Shakespeare                     |
| 210. Old English Literary Tradition             | 325. Studies in the English Drama of the        |
| 212. Middle English Literary Tradition          | Sixteenth and Seventeenth Centuries             |
| 215. Chaucer                                    | 329. Studies in the Metaphysical Poets          |
| 216. Chaucer                                    | 330. Studies in Dryden and His Age              |
| 221. English Prose and Poetry of the Sixteenth  | 337. Studies in Swift                           |
| Century   | 338. Samuel Johnson's Literary Criticism and    |
| 223. Spenser                                    | Related Topics                                  |
| 224. Shakespeare                                | 339. The Eighteenth-Century Novel               |
| 225, 226. Tudor and Stuart Drama, 1500-1642     | 341. Studies in English Romanticism             |
| 229, 230. English Literature of the Seventeenth | 343. Studies in Coleridge and Carlyle           |
| Century   | 347. Studies in Victorian Poetry                |
| 232. Milton                                     | 348. Studies in Victorian Fiction               |
| 234. English Drama, 1642-1800                   | 349. Studies in Nineteenth-Century              |
| 235, 236. The Eighteenth Century                | Nonfictional Prose                              |
| 241, 242. English Literature of the Early       | 353. Studies in British Poetry of the Twentieth |
| Nineteenth Century                              | Century   |
| 245, 246. English Literature of the Later       | 354. Studies in British Prose of the Twentieth  |
| Nineteenth Century                              | Century   |
| 251, 252. English Literature of the Twentieth   | 361. Studies in a Major American Author of the  |
| Century   | Early Nineteenth Century                        |
| 263, 264. American Literature, 1800-1865        | 362. Studies in a Major American Author of the  |
| 267, 268. American Literature, 1865-1915        | Later Nineteenth Century                        |
| 270, 271. Southern Literature                   | 364. Hawthorne and Melville                     |
| 275, 276. American Literature since 1915        | 368. Studies in American Realistic Fiction      |
| 280. Introduction to Folklore                   | 369. Studies in American Humor                  |
| 285. Literary Criticism                         | 376. Studies in Twentieth-Century American      |
| 287. Theory of Literature from Kant to the      | Literature                                      |
| Present   | 380. The Traditional Ballad and Folksong        |
| 310. Beowulf                                    | 383. Textual Criticism                          |
| 312. Studies in Middle English Literature       | 387. Special Topics Seminar                     |
| 315. Studies in Chaucer                         | 100. English for Foreign Students               |

## Forestry and Environmental Studies

### Professors

Roger Fabian Anderson, Ph.D. (Minnesota), *Director of Graduate Studies*; Robert Lloyd Barnes, Ph.D. (Duke); Henry Hellmers, Ph.D. (California at Berkeley); Benjamin A. Jayne, Ph.D. (Yale); Kenneth Richard Knoerr, Ph.D. (Yale); Jane Philpott, Ph.D. (Iowa); Charles William Ralston, Ph.D. (Duke); William James Stambaugh, Ph.D. (Yale).

### Associate Professors

Frank J. Convery, Ph.D. (State Univ. of New York); P. Aarne Vesilind, Ph.D. (North Carolina at Chapel Hill); David O. Yandle, Ph.D. (North Carolina State).

## Adjunct Associate Professors

Edgar W. Clark, Ph.D. (California at Berkeley); Charles S. Hodges, Jr., Ph.D. (Georgia); Louis John Metz, Ph.D. (Duke); Fred M. Vukovich, Ph.D. (St. Louis).

## Assistant Professors

R. Rajagopal, Ph.D. (Michigan); James E. Wuenscher, Ph.D. (Wisconsin).

Major and minor work is offered in the natural and social aspects of forestry and related areas of natural resources leading to the Master of Arts, Master of Science, and Doctor of Philosophy degrees. Work for these degrees may be pursued in the biological science areas of tree anatomy, forest ecology, tree physiology, biochemistry, forest entomology, and forest pathology; in the environmental science areas of forest soils, meteorology, and hydrology; in resource economics; and in forest mensuration, biometry, and operations research. College graduates who have had specialized training in professional forestry or in the related basic areas of the natural or social sciences will be considered for admission. Students will be restricted to the particular fields of specialization for which their academic background qualifies them. For information on professional training in forestry, the *Bulletin of the School of Forestry and Environmental Studies* should be consulted.

The specific degrees available in forestry and related natural resources through the Graduate School are: the A.M. (with or without a thesis), M.S. (with a thesis), and the Ph.D. Students majoring in forestry may be required to demonstrate satisfactory knowledge of one or two foreign languages for the Ph.D. degree. More information on degree and language requirements can be found in the program information section of the detailed *Bulletin of the Graduate School*.

## BIOLOGICAL SCIENCE

### *Dendrology and Wood Anatomy*

206 F. Anatomy of Woody Plants

241 F. Dendrology

292 F. Microtechnique of Woody Tissue

### *Ecology*

243 E.S. Natural Resource Ecology

277 F. Seminar in Natural Resource Allocation and Efficiency

337 E.S. Ecological Analysis for Environmental Management

340 E.S. Ecology and Land Use Planning

341 E.S. Ecological Principles in Environmental Management

346 E.S. Seminar in Environmental Policy

347, 348 E.S. Natural Resource Ecology—Environmental Management Seminar

349 E.S. Wildland and Wildlife Management

354 E.S. Biological and Resource System Simulation

### *Entomology*

222 F. Biology of Forest Insects and Diseases

225 F. Chemical Aspects of Forest Protection

230 F. Forest Entomology

233 F. General Entomology

331 F. Toxicology of Insecticides

332 F. Ecology of Forest Insects

335 F. Entomological Research Techniques

385 F. Seminar in Forest Protection

### *Pathology*

222 F. Biology of Forest Insects and Diseases

223 F. Forest Pathology

225 F. Chemical Aspects of Forest Protection

321 F. Phytopathological Technique in Forestry

322 F. Microbiology of Forest Soils

385 F. Seminar in Forest Protection

### *Physiology and Biochemistry*

205 F. Tree Growth and Development

207 F. Chemistry of Woody Tissues

208 F. Physiology of Wood Formation

225 F. Chemical Aspects of Forest Protection

305 F. Forest Biochemistry

## ENVIRONMENTAL SCIENCE

### *Soils*

261 F. Forest Soils

362 F. Forest Soil Physics

364 F. Soil Classification and Mapping

366 F. Forest Soil Fertility

## Meteorology

203 F. General Meteorology  
204 F. Microclimatology  
215 F. Air Pollution Meteorology  
217 F. Environmental Instrumentation

304 F. Atmospheric Turbulence and Diffusion\*  
306 F. Dynamics of Local Atmospheric Motion\*  
344 F. Micrometeorology and Biometeorology Seminar\*

## Hydrology

216 F. Watershed Hydrology

342 F. Hydrologic Processes\*

## RESOURCE ECONOMICS AND POLICY

269 F. Resource Economics and Policy  
270 F. Economics of Forestry  
273 E.S. Economics and Environmental Quality

277 F. Seminar in Natural Resource Allocation and Efficiency  
378 F. Seminar in Forest Economics

## STATISTICS AND OPERATIONS RESEARCH

250 F. Biometry  
251 F. Theory and Methods for Sampling Biological Populations  
253 F. Computer Science in Natural Resources  
258 F. Quantitative Analysis in Resource Management

352 F. Theory and Applications of Linear Statistical Models  
353 F. Design and Analysis of Experiments  
354 E.S. Biological and Resource System Simulation

## SPECIAL STUDIES AND RESEARCH

299 F. Special Studies in Forestry  
299 E.S. Independent Projects in Environmental Studies  
301, 302 F. Advanced Studies in Forestry

301, 302 E.S. Advanced Projects in Environmental Studies  
357, 358 F. Research in Forestry  
368 F. Field Seminars

# The University Program in Genetics

## Professors

D. Bernard Amos, M.D. (Guys Hospital, London); Nicholas Gillham, Ph.D. (Harvard); Samson R. Gross, Ph.D. (Columbia), *Director*; Walter R. Guild, Ph.D. (Yale).

## Associate Professors

Janis Antonovics, Ph.D. (Univ. Coll. of North Wales); John E. Boynton, Ph.D. (California at Davis); Sheila J. Counce, Ph.D. (Edinburgh); Calvin L. Ward, Ph.D. (Texas); Frances E. Ward, Ph.D. (Brown); Robert E. Webster, Ph.D. (Duke).

## Assistant Professors

Dwight H. Hall, Ph.D. (Purdue); Nicholas Kredich, M.D. (Michigan).

The University Program in Genetics provides a coherent course of study in all facets of biology related to genetics. Graduate students registered in any of the biological sciences departments may apply to the faculty of the genetics program to pursue study and research leading to an advanced degree. It would be helpful if applicants for admission to the Graduate School indicated their interest in the genetics program at the time of application. Requests for information describing more completely the research interests of the staff, facilities, and special stipends and fellowships should be addressed to the Director, Genetics Program (151 Nanaline H. Duke).

## Courses of Instruction

204. Introductory Genetics  
216. Molecular Genetics  
280. Principles of Genetics

282. Experimental Genetics  
284. Current Topics in Genetic Mechanisms  
285. Population Genetics

\*Offered on demand.

- 286. Evolutionary Mechanisms
- 287. Quantitative Genetics
- 288. Seminar on the Role of the Cell in Development and Heredity

- 336. Immunogenetics
- 351-352. Genetics Seminar

## Geology

### Professors

S. Duncan Heron, Jr., Ph.D. (North Carolina at Chapel Hill), *Chairman*; Ronald D. Perkins, Ph.D. (Indiana), *Director of Graduate Studies*; Orrin H. Pilkey, Ph.D. (Florida State).

### Associate Professors

William J. Furbish, M.S. (Wisconsin); George W. Lynts, Ph.D. (Wisconsin).

### Assistant Professor

Bruce R. Rosendahl, Ph.D. (California at San Diego).

The Department of Geology offers graduate work leading to the M.S. and Ph.D. degrees. An undergraduate degree in geology is not a prerequisite for graduate studies, but a student must have had or must take a summer field geology course (or equivalent experience), mineralogy, sedimentary rocks, stratigraphy, paleontology, and structural geology. In addition, the student must have had one year of college chemistry, one year of college physics, and mathematics through calculus.

Graduate courses in the Department of Geology are designed to provide specialized training in the fields of geological oceanography, sedimentology, stratigraphy, paleontology, geophysics, and low-temperature mineralogy.

An acceptable thesis is required. There is no language requirement for the M.S. degree.

The Ph.D. degree is available through the Earth Science Consortium, a new inter-university doctoral program combining the faculties and research facilities of Duke, Emory, and Tulane Universities. The Earth Science Consortium offers specialization in the areas of paleontology, sedimentology, stratigraphy, marine geology, geophysics, environmental geology, and regional geology. Under this program, a student admitted to Duke University would be expected to spend one year of study at another of the participating universities. Such a program offers the student a broadly-based faculty with diverse research interests and the opportunity to pursue graduate education in a variety of geologic settings. Normally, a candidate would hold the master's degree at the time of admission to the program. Additional information concerning the details of the doctoral program is available on request.

### Courses of Instruction

- |  |  |
|--|--|
| 205. Geological Oceanography                   | 251. Principles of Geophysics                          |
| 206S. Principles of Geological Oceanography    | 252. Marine Geophysics                                 |
| 208. Shallow-Marine Geology                    | 300. Seminar in Oceanography*                          |
| 211S. Stratigraphic Principles and Application | 305. Seminar in Continental Drift and Global Tectonics |
| 212. Facies Analysis                           | 310. Seminar in Stratigraphy*                          |
| 214S. Sediments in Thin Section                | 312. Seminar in Sedimentology*                         |
| 222. Sedimentary Minerals                      | 320. Seminar in Mineralogy*                            |
| 229. Economic Geology*                         | 330. Seminar in Geochemistry*                          |
| 230. Principles of Structural Geology          | 340. Seminar in Paleontology*                          |
| 241-242. Invertebrate Paleontology             | 350. Seminar in Geomathematics*                        |
| 243-244. Micropaleontology                     | 360. Seminar in Geophysics*                            |
| 247. Paleoecology                              | 371, 372. Advanced Topics in Geology*                  |
| 250. Introduction to Marine Geophysics         |  |

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\*Offered on demand.



# Germanic Languages and Literature

## Professor

Leland R. Phelps, Ph.D. (Ohio State), *Chairman and Director of Graduate Studies*.

## Associate Professors

Frank Borchardt, Ph.D. (Johns Hopkins); James L. Rolleston, Ph.D. (Yale).

## Assistant Professors

A. Tilo Alt, Ph.D. (Texas); Donald K. Rosenberg, Ph.D. (Ohio State).

The Department of Germanic Languages and Literature offers graduate work leading to the A.M. degree. Students who expect to major in German should have had sufficient undergraduate courses in Germanic languages to enable them to proceed to more advanced work.

Students who wish to take courses in German as a related field should normally have completed a third-year course (in exceptional cases, a second year) of college German with acceptable grades.

## Courses of Instruction

- |                                      |  |
|--------------------------------------|--|
| 2015, 2025. Goethe                   | 216. History of the German Language          |
| 2035. Eighteenth Century             | 2175. Renaissance and Reformation Literature |
| 205, 206. Middle High German         | 2185. The Teaching of German                 |
| 2075. German Romanticism             | 219. Applied Linguistics                     |
| 2095. Drama                          | 230. Lyric Poetry                            |
| 2115. Nineteenth-Century Literature  | 232. Criticism                               |
| 2145. The Twentieth Century          | 301. Gothic*                                 |
| 2155. Seventeenth-Century Literature | 321, 322. Germanic Seminar                   |

# Health Administration

## Professors

Montague Brown, D.P.H. (North Carolina at Chapel Hill); David G. Warren, J.D. (Duke).

## Adjunct Professor

Arnold D. Kaluzny, Ph.D. (Michigan).

## Associate Professors

Boi Jon Jaeger, Ph.D. (Duke), *Chairman*; Barbara McCool, Ph.D. (Ohio State); Wilma A. Minniear, M.S.N. (Case Western Reserve); Louis E. Swanson, A.B. (Hamilton).

## Visiting Associate Professor

Gaylord Cummins, Ph.D. (Johns Hopkins), M.P.H. (Tulane).

## Adjunct Associate Professors

Elizabeth J. Coulter, Ph.D. (Radcliffe); Richard H. Peck, M.H.A. (Duke).

## Assistant Professors

Mary M. Blanks, M.H.A. (Duke); Thomas J. Delaney, M.S. (U.S. Naval Postgraduate School); David J. Falcone, Ph.D. (Duke); Donald S. Smith II, M.H.A. (Minnesota), *Director of Graduate Studies*; David Michael Warner, Ph.D. (Tulane).

## Lecturer

Robert G. Winfree, M.A. (Iowa).

\*Offered on demand.

## Associate

David P. Hunter, M.P.H. (Pittsburgh).

Graduate study leading toward preparation for a career in the administration of all types of health organizations and programs is offered through a twenty-month academic program that leads to the M.H.A. degree. Students without previous administrative experience in the health field are urged to undertake a twelve-month administrative residency following graduation. This residency is a period of varied administrative experience that is conducted under faculty supervision and is individually designed around each student's interests. For students without previous administrative experience, the residency should be considered an integral part of the M.H.A. program. Admission to this program is based upon suitability of the candidate to assume leadership roles in the organization and management of the delivery of health services, as well as on capability for graduate study.

## Courses of Instruction

- |  |  |
|--|--|
| 301. The Health System and Its Environment         | 335. Ambulatory Health Services                          |
| 312. Comparative Health Systems                    | 341, 342. Case Studies in Health Administration          |
| 314. Social Dimensions of Health Services          | 344. Health Manpower                                     |
| 321. Operations Research for Health Administration | 346. Community Health Services                           |
| 322. Public Policy and Health Care                 | 348. Legal and Regulatory Constraints on Health Services |
| 324. Institutional Health Services                 | 360. Seminar in Health Administration                    |
| 326. Health Economics                              | 371, 372. Directed Research                              |
| 331, 332. Planning Health Services                 |  |

## Management Sciences Courses for Students in Health Administration

- |   |                                      |
|---|--------------------------------------|
| MS 300. Managerial Economics                          | MS 330. Accounting Systems I         |
| MS 310. Quantitative Methods                          | MS 331. Accounting Systems II        |
| MS 311. Statistical Analysis for Management Decisions | MS 384. Market Structures            |
| MS 320. Organization Analysis and Design              | MS 385. Short- and Long-Run Planning |

## History

### Professors

Joel G. Colton, Ph.D. (Columbia); Calvin D. Davis, Ph.D. (Indiana); Robert F. Durden, Ph.D. (Princeton), *Chairman*; Arthur B. Ferguson, Ph.D. (Cornell); Irving B. Holley, Jr., Ph.D. (Yale); Frederic Hollyday, Ph.D. (Duke); Warren Lerner, Ph.D. (Columbia); John F. Oates, Ph.D. (Yale); Richard A. Preston, Ph.D. (Yale), *William K. Boyd Professor of History*; Theodore Ropp, Ph.D. (Harvard); Anne Firor Scott, Ph.D. (Radcliffe); William E. Scott, Ph.D. (Yale); John J. TePaske, Ph.D. (Duke); Richard L. Watson, Ph.D. (Yale); Charles Young, Ph.D. (Cornell), *Director of Graduate Studies*.

### Associate Professors

John Cell, Ph.D. (Duke); William Chafe, Ph.D. (Columbia); Raymond Gavins, Ph.D. (Virginia); Lawrence C. Goodwyn, Ph.D. (Texas); Gerald Hartwig, Ph.D. (Indiana); Seymour Mauskopf, Ph.D. (Princeton); Charles S. Maier, Ph.D. (Harvard); Martin Miller, Ph.D. (Chicago); Sydney Nathans, Ph.D. (Johns Hopkins); Ronald Witt, Ph.D. (Harvard); Peter H. Wood, Ph.D. (Harvard).

### Assistant Professors

Charles W. Bergquist, Ph.D. (Stanford); Arif Dirlik, Ph.D. (Rochester); Alan Stone, Ph.D. (Washington Univ.).

### Visiting Professors

Larry Holbrook Addington, Ph.D. (Duke); Don Higginbotham, Ph.D. (Duke).

The Department of History offers graduate work leading to the A.M. and Ph.D. degrees. Candidates for the A.M. degree must have a reading knowledge of at least one ancient or modern foreign language related to their programs of study and have completed successfully a substantial research paper, normally the product of a year's seminar or two semester-courses. The paper must be approved by two readers—the supervising professor and a sec-

and professor from the graduate staff. Students anticipating a May degree must have their papers read and approved by April 15; those anticipating a September degree must have their papers read and approved by August 15.

Candidates for the degree of Doctor of Philosophy are required to prepare themselves for examinations in four fields. Three usually shall be history. The choice of fields is determined in consultation with the student's supervisor and the Director of Graduate Studies. The department offers graduate instruction in the fields of Africa, Afro-American history, ancient history, medieval and early modern Europe, modern Europe, American history, Britain and the Commonwealth, imperial Russia, modern Russia, Latin America, South Asia, modern China, modern Japan, military history, history of science, and history of medicine. The candidate for the Ph.D. degree usually must have a reading knowledge of two foreign languages, but in certain cases where the candidate's supervisor and the Director of Graduate Studies approve, and where the candidate's research for the dissertation would appreciably benefit, an alternative to the second language may be accepted. This alternative usually would take the form of successfully completed formal training in an auxiliary discipline (such as statistics or a course in one of the other social sciences with an emphasis upon methodology) of 3 to 6 units, or the equivalent, depending on the student's program. It also must be in addition to any previous undergraduate work in the discipline. The requirement, whether satisfied by two languages or by one language and an alternative, must be met prior to the preliminary examination.

### Courses of Instruction

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|--|---|
| 201S, 202S. Aspects of Change in Prerevolutionary Russia                     | 248. History of Modern India and Pakistan, 1857 to the Present        |
| 203. The Uses of History in Public Policy: I                                 | 249-250. Social and Intellectual History of the United States         |
| 204. The Uses of History in Public Policy: II                                | 255S-256S. Problems in African History                                |
| 205S. Progressive Era in the United States and World War I                   | 260. Economic History of Japan  |
| 206S. The Nineteen Twenties and the New Deal in the United States            | 261-262. Problems in Soviet History                                   |
| 207S, 208S. The Development of Urban America                                 | 263-264. American Colonial History and the Revolution, 1607-1789      |
| 209, 210. Selected Topics in Afro-American History, 1619-Present             | 265S, 266S. Problems in Modern Latin American History                 |
| 212. Recent Interpretations of United States History                         | 267S-268S. From Medieval to Early Modern England                      |
| 215-216. The Diplomatic History of the United States                         | 269-270. British History, Seventeenth Century to the Present          |
| 217. Fascism and Its Background  | 272. Poverty in the United States: A Historical Perspective           |
| 218. Twentieth-Century Europe  | 273, 274. Topics in the History of Science                            |
| 221. Problems in the Economic and Social History of Europe, 1200-1700        | 275S, 276S. Central Europe, 1848-1918                                 |
| 222. Problems in European Intellectual History, 1250-1550                    | 277S. The Coming of the Civil War in the United States, 1820-1861     |
| 223S, 224S. The Old Regime, the Enlightenment, and the French Revolution     | 278S. The Civil War in the United States and its Aftermath, 1861-1900 |
| 227-228. Recent United States History: Major Political and Social Movements  | 280. Historiography   |
| 229. Recent Interpretations of Modern European History                       | 283. Political and Social Change in the United States, 1789-1860      |
| 231S, 232S. Problems in the History of Spain and the Spanish Empire          | 285S, 286S. Oral History  |
| 234. Political Economy of Development: Theories of Change in the Third World | 287-288. History of Modern Japan                                      |
| 237S. Europe in the Early Middle Ages  | 297S. The British Empire of the Nineteenth Century                    |
| 238S. Europe in the High Middle Ages   | 298S. The Commonwealth in the Twentieth Century                       |
| 240. Aspects of Traditional and Modern African Culture                       | 307-308. Seminar in United States History                             |
| 241-242. Modernization and Revolution in China                               | 317-318. Seminar in the History of Western Europe                     |
| 247. History of Modern India and Pakistan, 1707-1857                         | 371-372. Research Seminars  |
|  | 401. Seminar on the British Commonwealth                              |
|  | 312. Seminar in the Teaching of History in College                    |
|  | 314. Historical and Social Science Methodology                        |
|  | 399. Independent Study  |

# Marine Sciences—The University Program

## Professors

Cazlyn Green Bookhout, Ph.D. (Duke); John Costlow, Ph.D. (Duke), *Director*; Terry W. Johnson, Jr.,\* Ph.D. (Michigan); Orrin Pilkey,\* Ph.D. (Florida State).

## Associate Professors

Richard T. Barber, Ph.D. (Stanford); Richard B. Searles,\* Ph.D. (California at Berkeley).

## Assistant Professors

Rodger W. Baier, Ph.D. (Washington); Richard B. Forward, Ph.D. (California at Santa Barbara); John Gutknecht, Ph.D. (North Carolina at Chapel Hill); J. Bolling Sullivan, Ph.D. (Texas); John Sutherland, Ph.D. (California at Berkeley).

Training in the marine sciences at Duke University includes marine biology, marine geology, and oceanography. The departments which are chiefly concerned are botany, chemistry, geology, and zoology.

Graduate students working in the marine sciences will take their degrees under the auspices of one of the above departments and must, therefore, meet the requirements of that department. During the first part of the training the student will usually take courses on the Durham campus during the academic year and enroll in more specialized courses in the marine sciences at the Duke University Marine Laboratory during the summer. After the completion of the course work and preliminary examination (for doctoral candidates) the candidate may, with approval of the major professor, request space for thesis research at the Marine Laboratory.

Persons interested in graduate work in marine sciences should apply through one of the appropriate departments. Forms may be obtained from the Graduate School.

Applications for summer courses at the Laboratory should be addressed to the Director, Duke University Marine Laboratory, Beaufort, North Carolina 28516. The form may be obtained from the Duke University *Marine Laboratory Bulletin*. The application for enrollment in the Duke University summer session should be accompanied by transcripts of undergraduate and graduate work. Applications should be received before March 10.

Students registering for research should do so under the appropriate departmental numbers.

The following courses are offered during the summer at Beaufort. See the Duke University *Marine Laboratory Bulletin* for the current schedule of courses.

## Courses of Instruction

- |  |  |
|--|--|
| 202. Phytoplankton Systematics               | 240. Chemical Oceanography                     |
| 203. Marine Ecology                          | 250. Physiological Ecology of Marine Animals   |
| 204. Marine Microbiology                     | 252. Marine Electrobiolgy                      |
| 205. Geological Oceanography                 | 274. Marine Invertebrate Zoology               |
| 211. Marine Phycology                        | 276. Comparative and Evolutionary Biochemistry |
| 212. Membrane Physiology and Osmoregulations | 278. Invertebrate Embryology                   |
| 214. Biological Oceanography                 | 353, 354. Research                             |
| 230. Environmental Oceanography              |  |

## Mathematics

### Professors

William K. Allard, Ph.D. (Brown); James Greig Arthur, Ph.D. (Yale); Leonard Carlitz, Ph.D. (Pennsylvania), *James B. Duke Professor of Mathematics*; Francis Joseph Murray, Ph.D. (Columbia); Michael C. Reed, Ph.D. (Stanford); Joseph Robert Shoenfield, Ph.D. (Michigan); Seth L. Warner, Ph.D. (Harvard), *Chairman*; Morris Weisfeld, Ph.D. (Yale), *Director of Graduate Studies*.

\*In residence at the Marine Laboratory during the summer only.



## Associate Professors

Donald Stanley Burdick, Ph.D. (Princeton); Richard Earl Hodel, Ph.D. (Duke); Joseph W. Kitchen, Jr., Ph.D. (Harvard); David P. Kraines, Ph.D. (California at Berkeley); Lawrence Carlton Moore, Jr., Ph.D. (California Inst. of Tech.); Richard A. Scoville, Ph.D. (Yale); David A. Smith, Ph.D. (Yale).

## Adjunct Associate Professor

Jagdish Chandra, Ph.D. (Rensselaer).

## Assistant Professors

Edmund Butler, Ph.D. (New York Univ.); Murray Cantor, Ph.D. (California at Berkeley); Jack A. Lees, Ph.D. (Chicago); Philip E. Protter, Ph.D. (California at San Diego); Bruce A. Reznick, Ph.D. (Stanford); Robert L. Wolpert, Ph.D. (Princeton).

Graduate work in the Department of Mathematics is offered leading to the M.S., A.M., and Ph.D. degrees. Students, in their undergraduate work, must have had courses in differential and integral calculus, and at least 6 semester hours of other courses in mathematics on the junior or senior level.

The department offers a program in applied statistics with a minor in computer science leading to the M.S. degree. The program consists of 24 units of graded course work plus a thesis involving the use of the computer.

All A.M. and Ph.D. degree candidates are required to pass a comprehensive examination in the areas of real and complex analysis and algebra. Students will usually take the comprehensive examination after completing their first year of graduate study and just prior to the start of their second year.

The A.M. degree with a major in mathematics is awarded primarily on the basis of scholarship. It requires 30 units of graded work in addition to the comprehensive examination. A thesis may be substituted for 6 units of course work only in unusual circumstances.

The Ph.D. degree in mathematics is awarded upon the demonstration of ability and training in research. The original dissertation, therefore, is the most important of the formal requirements for the degree.

Since a reading knowledge of French, German, and Russian is highly desirable for a student of mathematics, the Ph.D. degree candidate should satisfy the language requirement in two of these languages as early as possible. The department offers departmentally administered language examinations as an alternative to the ETS examinations.

## Courses of Instruction

- |   |   |
|---|---|
| 204. Geometry for Teachers                          | 274. Geometric Topology                                 |
| 206. Introduction to Stochastic Processes           | 275, 276. Probability                                   |
| 207, 208. Introduction to Algebraic Structures      | 284. Least Squares Analysis of Linear Models            |
| 217, 218. Intermediate Analysis                     | 285. Applied Mathematical Methods I                     |
| 221, 222, 223. Numerical Analysis                   | 286. Applied Mathematical Methods II                    |
| 227, 228. Theory of Numbers*                        | 287, 288. Foundations of Mathematics*                   |
| 229, 230. Algebraic Numbers*                        | 289. Mathematical Methods in Quantum Mechanics          |
| 231. Applications of Graph Theory                   | 290. Stochastic Processes                               |
| 234. Sample Designs*                                | 291, 292. Analysis I, II                                |
| 235, 236. Algebra                                   | 293. Multivariate Statistics                            |
| 244. Analysis of Variance                           | 295. Mathematical Foundations of Statistical Inference* |
| 245, 246. Combinatorial Analysis*                   | 297, 298. Axiomatic Set Theory                          |
| 247, 248. Arithmetic of Polynomials*                | 303, 304. Advanced Theory of Numbers*                   |
| 256. Orientation for Applied Mathematics            | 325, 326. Analysis III, IV                              |
| 260. Design of Experiments                          | 327, 328. Partial Differential Equations*               |
| 262. Non-Parametric Statistics*                     | 329, 330. Theory of Distributions*                      |
| 265, 266. Homological Algebra and Its Applications  | 331, 332. Advanced Topics in Complex Variables*         |
| 268. Mathematical Foundations of General Relativity | 333, 334. Analytic Theory of Numbers*                   |
| 269, 270. Recursive Function Theory                 | 335, 336. Topics in Algebra*                            |
| 271. Point Set Topology                             | 343, 344. Differential Equations*                       |
| 272. Introductory Algebraic Topology                | 353, 354. Topics in Analysis*                           |
| 273. Algebraic Topology                             |   |

\*Offered on demand.

- 361, 362. Hilbert Space  
371, 372. Dimension Theory\*  
375. Advanced Point Set Topology  
377, 378. Topics in Topology\*  
383, 384. Lie Groups and Algebras\*  
392. Nuclear Spaces\*

## FRENCH

- |  |   |
|--|---|
| <p>213. French Literature of the Seventeenth Century</p> <p>214. The "Moralistes" of the Seventeenth Century</p> <p>219. Old French Literature</p> | <p>224. History of the French Language</p> <p>225. French Prose of the Sixteenth Century</p> <p>226. French Poetry of the Sixteenth Century</p> <p>311, 312. French Seminar (Medieval and Renaissance Topics)</p> |
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## ITALIAN

- |                                     |                             |
|-------------------------------------|-----------------------------|
| <p>284. Dante</p> <p>285. Dante</p> | <p>288. The Renaissance</p> |
|-------------------------------------|-----------------------------|

## SPANISH

- |   |   |
|---|---|
| <p>251. The Origins of Spanish Prose Fiction</p> <p>252. Spanish Lyric Poetry before 1700</p> <p>253. The Origin of the Spanish Theater</p> <p>257. History of the Spanish Language</p> <p>258. Medieval Literature</p> | <p>265. Cervantes</p> <p>266. Drama of the Golden Age</p> <p>321, 322. Hispanic Seminar (Medieval and Renaissance Topics)</p> |
|---|---|

# Microbiology and Immunology

## Professors

D. Bernard Amos, M.D. (Guys Hospital, London), *James B. Duke Professor of Immunology*; Richard O. Burns, Ph.D. (Illinois); Eugene D. Day, Ph.D. (Delaware); Wolfgang Karl Joklik, D.Phil. (Oxford), *James B. Duke Professor of Microbiology and Immunology and Chairman*; Richard S. Metzgar, Ph.D. (Buffalo); Suydam Osterhout, M.D. (Duke), Ph.D. (Rockefeller Inst.); Robert W. Wheat, Ph.D. (Washington); Hilda Pope Willett, Ph.D. (Duke), *Director of Graduate Studies*.

## Associate Professors

Dani P. Bolognesi, Ph.D. (Duke); C. Edward Buckley III, M.D. (Duke); Rebecca Buckley, M.D. (North Carolina at Chapel Hill); David J. Lang, M.D. (Harvard); Wendell Rosse, M.D. (Chicago); David W. Scott, Ph.D. (Yale); H. F. Seigler, M.D. (North Carolina at Chapel Hill); Ralph E. Smith, Ph.D. (Colorado); Ralph Snyderman, M.D. (State Univ. of New York, Downstate Medical Ctr.); Thomas C. Vanaman, Ph.D. (Duke); Frances E. Ward, Ph.D. (Brown); Hans Zweerink, Ph.D. (Cornell).

## Assistant Professors

Jeffrey J. Collins, Ph.D. (Harvard); Peter Cresswell, Ph.D. (London); Jeffrey R. Dawson, Ph.D. (Case Western Reserve); Linda R. Gooding, Ph.D. (Cornell); Hillel S. Koren, Ph.D. (Freiburg); Peter K. Lauf, M.D. (Freiburg); Jonathan P. Leis, Ph.D. (Cornell); Nelson Levy, M.D. (Columbia), Ph.D. (Duke); Sara Elizabeth Miller, Ph.D. (Georgia); Thomas G. Mitchell, Ph.D. (Tulane).

The department offers graduate work leading to the Ph.D. degree. Specialization is possible in molecular virology, viral oncology, cell biology, microbial physiology, immunochemistry, immunogenetics, cancer immunology, and general immunology.

Undergraduate preparation in biochemistry and physical chemistry is required. A brochure describing the Ph.D. degree program, prerequisites for admission, and research in the department can be obtained by writing the Director of Graduate Studies, Box 3020, Duke Medical Center.

## Courses of Instruction

- |   |   |
|---|---|
| <p>212, 213. Research Techniques in Microbiology and Immunology</p> <p>219. Molecular and Cellular Basis of Development</p> <p>219S. Seminar</p> <p>221. Medical Microbiology</p> <p>233. Microbiology</p> <p>242. Mechanisms of Microbial Pathogenicity</p> <p>252. General Virology and Viral Oncology</p> <p>282. Molecular Microbiology</p> | <p>291. Basic Immunology</p> <p>296. Immunochemistry</p> <p>323. Readings in Bacteriology and Immunology</p> <p>325. Medical Mycology</p> <p>330. Medical Immunology</p> <p>331.1-331.8. Microbiology Seminar</p> <p>332.1-332.8. Immunology Seminar</p> <p>336. Immunogenetics</p> <p>420. Cellular Immunophysiology</p> |
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# Pathology

## Professors

Bernard F. Fetter, M.D. (Duke); Donald B. Hackel, M.D. (Harvard); Robert E. Jennings, M.D. (Northwestern), *Chairman*; William W. Johnston, M.D. (Duke); Thomas D. Kinney, M.D. (Duke), *R. J. Reynolds Tobacco Company Professor of Medical Education*; Gordon K. Klintworth, M.B., Ph.D. (Witwatersrand); Philip Pratt, M.D. (Johns Hopkins); Joachim R. Sommer, M.D. (Munich), *Director of Graduate Studies*; F. Stephen Vogel, M.D. (Western Reserve); Benjamin Wittels, M.D. (Minnesota).

## Associate Professors

Dolph O. Adams, M.D., Ph.D. (North Carolina at Chapel Hill); Darell D. Bigner, M.D., Ph.D. (Duke); Edward H. Bossen, M.D. (Duke); William D. Bradford, M.D. (Western Reserve); Charles Daniels, M.D., Ph.D. (Duke); Jane G. Elchlepp, Ph.D. (Chicago), M.D. (Iowa); Craig Tisher, M.D. (Washington Univ.); Peter Zwadyk, Jr., Ph.D. (Iowa).

## Assistant Professors

Peter Anderson, Ph.D. (Oregon); Peter C. Burger, M.D. (Northwestern); Doyle G. Graham, M.D., Ph.D. (Duke); Hal Hawkins, M.D., Ph.D. (Duke); Keith Arnold Reimer, Ph.D., M.D. (Northwestern); John D. Shelburne, M.D., Ph.D. (Duke); Robin T. Vollmer, M.D. (Duke).

The Department of Pathology offers graduate work leading to the M.S. and Ph.D. degrees with areas of specialization such as subcellular and molecular pathology. Course work is designed to give a broad background in classical and modern pathology with emphasis on the application of modern research techniques. Students will be required to take such courses as are necessary to obtain a broad foundation, as well as courses applicable to areas of speciality and research. Further information including brochures giving details of departmental facilities, staff, trainee stipends, and the M.D.-Ph.D. program are available from the Director of Graduate Studies.

## Courses of Instruction

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|--|---|
| 219. Molecular and Cellular Basis of Development | 360. Cytochemistry                                      |
| 219S. Seminar                                    | 361, 362. Autopsy Pathology                             |
| 250. General Pathology                           | 364. Systemic Pathology                                 |
| 251. Laboratory Course in General Pathology      | 367, 368. Special Topics in Pathology                   |
| 258. Cellular and Subcellular Pathology          | 369. Ophthalmic Pathology                               |
| 275. Fundamentals of Electron Microscopy         | 370. Developmental Pathology and Teratology             |
| 325. Cardiovascular Pathology                    | 373. Cytopathology                                      |
| 352. Basic Problems in Chemical Pathology        | 374. Pulmonary Pathology and Postmortem Pathophysiology |
| 353. Advanced Neuropathology                     | 377. Pathology of the Kidney                            |
| 355, 356. Graduate Seminar in Pathology          | 378. Immunopathology                                    |
| 357. Research in Pathology                       | 379. Pathology of Virus Infections                      |

# Philosophy

## Professors

Martin P. Golding, Ph.D. (Columbia), *Chairman*; William Bernard Peach, Ph.D. (Harvard); Paul Welsh, Ph.D. (Cornell).

## Associate Professors

Edward P. Mahoney, Ph.D. (Columbia); George W. Roberts, Ph.D. (Cambridge), *Director of Graduate Studies*; David H. Sanford, Ph.D. (Cornell).

## Assistant Professor

David J. Ross, Ph.D. (Stanford).

## Visiting Assistant Professors

Paul V. Bamford, Ph.D. (North Carolina at Chapel Hill); Gregory Boudreaux, Ph.D. (Duke).



The Department of Philosophy offers graduate work leading to the A.M. and Ph.D. degrees. Tutorial work complements formal instruction. Students may specialize in any of the following fields: the history of philosophy, logic, philosophy of science, epistemology, metaphysics, philosophy of mind, philosophical analysis, ethics, aesthetics, political philosophy, philosophy of law, philosophy of medicine, and philosophy of religion.

Individual programs of study are developed for each student. The following requirements, however, are fundamental: (1) In February of their first year new graduate students are required to take one or two qualifying examinations, diagnostic in purpose. One examination tests ability to deal critically and systematically with some basic philosophical topic; a second examination, in logic, is required of anyone who has not taken a graduate-level logic course during the first term. (2) The preliminary examination for the Ph.D. degree, which may be taken only after a student has met the language requirement for that degree, should be taken after the second year of study. In these examinations students are expected to combine historical knowledge with critical understanding.

Work in a minor or related field, not necessarily confined to any one department, is encouraged but not required. A minor normally includes 6 units for the A.M. or the Ph.D. degree and may include more as a student's program requires or permits.

A student who meets the general requirements of the Graduate School for the A.M. degree may earn this degree by satisfying the foreign language requirement and by passing the preliminary examination for the Ph.D. degree or by writing and successfully defending a master's thesis.

A reading knowledge of at least one foreign language, ancient or modern, is required for the Ph.D. degree. Students may not take their preliminary examinations until they have demonstrated this ability. More than one language may be required where this is judged appropriate to the research demanded by the candidate's dissertation.

Courses of Instruction

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|---|---|
| 202. Aesthetics: The Philosophy of Art  | 233. Methodology of the Empirical Sciences        |
| 203. Contemporary Ethical Theories      | 234. Problems in the Philosophy of Science        |
| 204. Philosophy of Law                  | 241. Symbolic Logic                               |
| 205. Philosophy of History              | 251. Epistemology                                 |
| 206. Topics in Ethical Theory           | 252. Metaphysics                                  |
| 208. Political Values                   | 253. Philosophy of Mind                           |
| 211. Plato                              | 254. Philosophy of Religion                       |
| 217. Aristotle                          | 255. Philosophy of Action                         |
| 218. Medieval Philosophy                | 260. Wittgenstein                                 |
| 225. British Empiricism                 | 287, 288. Foundations of Mathematics              |
| 227. Continental Rationalism            | 291, 292. Seminar in Special Fields of Philosophy |
| 228. Recent and Contemporary Philosophy | 331, 332. Seminar in Special Fields of Philosophy |
| 230. The Meaning of Religious Language  |   |
| 231. Kant's Critique of Pure Reason     |   |
| 232. Recent Continental Philosophy      |   |

Physical Therapy

Professor

Robert Charles Bartlett, M.A. (New York Univ.), *Chairman*.

Associate Professors

Eleanor F. Branch, Ph.D. (Duke), *Director of Graduate Studies*; Elia E. Villanueva, A.M. (Duke).

Assistant Professors

Elaine M. Eckle, M.A. (North Carolina at Chapel Hill); Grace C. Horton, B.S. (Albright).

Associates

Marjory A. Cannon, M.M.Sc. (Emory); Linda K. George, Ph.D. (Duke); Mary Martin Huse, Ph.D. (Duke); Nancy H. Stafford, B.S. (Indiana); Kathleen A. Zeitschel, M.M.S. (Emory).

## Adjunct Assistant Professor

Marcia J. Roses, B.S. (Northeastern).

The Department of Physical Therapy offers a basic professional program leading to the M.S. degree. To be eligible for admission to the program, applicants must have obtained a baccalaureate degree and have a background in the basic sciences and social sciences including course work in biology, chemistry, physics, psychology, and statistics. In the first year of the curriculum students are required to take courses in anatomy and physiology, offered by those respective departments. Further information may be obtained from the Director of Graduate Studies, Department of Physical Therapy, Box 3965, Duke University Medical Center, Durham, N.C. 27710.

## Courses of Instruction

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|---|---|
| 201, 202. Seminar in Physical Therapy                   | 243, 244. Directed Clinical Experience in Physical Therapy II |
| 217. Physical Therapy Dynamics I                        | 297, 298. Special Topics in Physical Therapy                  |
| 218. Physical Therapy Dynamics II                       | 301. Introduction to Scientific Inquiry                       |
| 220. Physical Therapy Dynamics III                      | 315. Curriculum Development                                   |
| 230, 231. Physical Evaluation and Instrumentation       | 316. Directed Teaching in Physical Therapy                    |
| 234. Introductory Pathology                             | 332. Administration of Physical Therapy Services              |
| 236. Medical Sciences                                   | 350. Research   |
| 238. Introduction to Health Service Systems             |   |
| 240. Prosthetics and Orthotics                          |   |
| 242. Directed Clinical Experience in Physical Therapy I |   |

## Physics

### Professors

L. C. Biedenharn, Jr., Ph.D. (Massachusetts Inst. of Tech.); Edward G. Bilpuch, Ph.D. (North Carolina at Chapel Hill); Henry A. Fairbank, Ph.D. (Yale); Walter Gordy, Ph.D. (North Carolina at Chapel Hill), LL.D., D.H.C., *James B. Duke Professor of Physics*; Harold W. Lewis, Ph.D. (Duke); Horst Meyer, Docteur ès sciences (Geneva); Henry W. Newson, Ph.D. (Chicago), *James B. Duke Professor of Physics*; N. Russell Roberson, Ph.D. (Johns Hopkins); Hugh G. Robinson, Ph.D. (Duke); William D. Walker, Ph.D. (Cornell), *Chairman*; Richard L. Walter, Ph.D. (Notre Dame).

### Associate Professors

Ron Y. Cusson, Ph.D. (California Inst. of Tech.); Frank C. DeLucia, Ph.D. (Duke); Lawrence E. Evans, Ph.D. (Johns Hopkins), *Director of Graduate Studies*; Lloyd R. Fortney, Ph.D. (Wisconsin); Moo-Young Han, Ph.D. (Rochester).

### Assistant Professors

Zvi Friedman, Ph.D. (Tel Aviv); Alfred T. Goshaw, Ph.D. (Wisconsin); Dewey T. Lawson, Ph.D. (Duke); Paul W. Lisowski, Ph.D. (Duke); James S. Loos, Ph.D. (Illinois); Robert Kent Smith, Jr., Ph.D. (Maryland).

### Adjunct Professors

Fearghus O'Foghludha, Ph.D. (National Univ. of Ireland); Herman Robl, Ph.D. (Vienna); Katherine Way, Ph.D. (North Carolina at Chapel Hill).

The Department of Physics offers graduate work for students wishing to earn the A.M. or Ph.D. degree. In addition to a balanced program of basic graduate courses, the department offers specialized courses and seminars in several fields in which research is being done by students, faculty, and staff.

With the help of faculty advisers, students select a course program to fit their needs, including work in a related field, usually mathematics or chemistry. Students are encouraged to begin research work early in their careers.

The department does not ordinarily accept students for work toward the A.M. degree only, and students making good progress are advised to work directly for the Ph.D. degree. The option of taking the A.M. without thesis is available with the approval of a departmental committee.

A reading knowledge of one language, usually chosen from French, German, or Russian, is required for the Ph.D. degree.

### Courses of Instruction

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|---|---|
| 211, 212. Advanced Modern Physics                   | 310. Solid State Physics II*                      |
| 215. Introduction to Quantum Mechanics              | 312. Phase Transitions and Critical Phenomena     |
| 217S, 218S. Advanced Physics Laboratory and Seminar | 316. Principles of Quantum Theory                 |
| 220. Electronics                                    | 317. Intermediate Quantum Theory                  |
| 223. Electricity and Magnetism                      | 318. Electromagnetic Field Theory                 |
| 268. Mathematical Foundations of General Relativity | 330. Nuclear Structure Theory*                    |
| 280. Nuclear Reactor Physics                        | 331. Microwave Radiation*                         |
| 282. Mechanics of Continuous Media                  | 335. Microwave Spectroscopy*                      |
| 302. Advanced Mechanics                             | 341. Advanced Topics in Quantum Theory*           |
| 303. Statistical Mechanics                          | 342. Theory of Elementary Particles*              |
| 304. Advanced Topics in Statistical Mechanics*      | 343. Nuclear Physics*                             |
| 305. Introduction to Nuclear Physics                | 344. Advanced Nuclear Physics*                    |
| 306. Low Temperature Physics*                       | 345. High Energy Physics*                         |
| 308. Introduction to High Energy Physics            | 346. Topics in Theoretical Physics*               |
| 309. Solid State Physics I                          | 351, 352. Seminar                                 |
|   | 397, 398. Low Temperature and Solid State Seminar |

## Physiology and Pharmacology

### Professors

F. Bernheim, Ph.D. (Cambridge), *James B. Duke Professor of Pharmacology*; J. J. Blum, Ph.D. (Chicago); George H. Hitchings, Ph.D. (Harvard); F. Jöbsis, Ph.D. (Michigan); E. A. Johnson, M.D. (Sheffield); L. Lack, Ph.D. (Columbia); Robert Arthur Maxwell, Ph.D. (Princeton); J. W. Moore, Ph.D. (Virginia); T. Narahashi, Ph.D. (Tokyo); Charles Adams Nichol, Ph.D. (Wisconsin); Athos Ottolenghi, M.D. (Pavia), *Director of Graduate Studies*; S. Schanberg, Ph.D., M.D. (Yale); G. Somjen, M.D. (New Zealand).

### Associate Professors

N. C. Anderson, Ph.D. (Purdue); Peter Brian Bennett, Ph.D. (Southampton); J. Gutknecht, Ph.D. (North Carolina at Chapel Hill); Johannes A. Kylstra, M.D., Ph.D. (Leiden); P. K. Lauf, M.D. (Freiburg); Melvyn Lieberman, Ph.D. (State Univ. of New York, Downstate Medical Ctr.); T. J. McManus, M.D. (Boston); L. M. Mendell, Ph.D. (Massachusetts Inst. of Tech.); Daniel B. Menzel, Ph.D. (California at Berkeley); E. Mills, Ph.D. (Columbia); G. M. Padilla, Ph.D. (California at Los Angeles); Herbert S. Posner, Ph.D. (George Washington); J. V. Salzano, Ph.D. (Iowa), *Acting Chairman*; Theodore A. Slotkin, Ph.D. (Rochester); Madison S. Spach, M.D. (Duke); M. Wolbarsht, Ph.D. (Johns Hopkins).

### Assistant Professors

Reginald D. Carter, Ph.D. (Bowman Gray); Joseph Ellinwood, Jr., M.D. (North Carolina at Chapel Hill); Joseph C. Greenfield, M.D. (Emory); James E. Hall, Ph.D. (California at Riverside); Harold E. Lebovitz, M.D. (Pittsburgh); Lazaro J. Mandel, Ph.D. (Pennsylvania); Donald H. Namm, Ph.D. (Albany Medical College); Gerald M. Rosen, Ph.D. (Clarkson); Myron Rosenthal, Ph.D. (Duke); C. W. Schomberg, Ph.D. (Purdue); James M. Schooler, Ph.D. (Wisconsin); Harold C. Strauss, M.D. (McGill); H. C. Wachtel, Ph.D. (New York Univ.); Andrew G. Wallace, M.D. (Duke).

### Assistant Medical Research Professors

Mohamed Bahie Abou-Donia, Ph.D. (California at Berkeley); Walter N. Duran, Ph.D. (Catholic Univ., Chile); Philip A. McHale, Ph.D. (Duke); Fidel Ramon, Ph.D. (Duke); Sidney A. Simon, Ph.D. (Northwestern); Chau H. Wu, Ph.D. (Miami); June-Zoo Yeh, Ph.D. (Missouri).

### Associate

Wilkie A. Wilson, Jr., Ph.D. (Duke).

The Department of Physiology and Pharmacology offers graduate work leading to the Ph.D. degree. Before undertaking this program a student should have a strong background

\*Offered on demand.

in basic sciences including course work in mathematics, biology, physics, and chemistry through physical chemistry. Undergraduates with this background may have majors in any of the following areas: biology, chemistry, physics, or engineering. There is no foreign language requirement. All graduate students are required to take the introductory courses in both physiology and pharmacology. A brochure which describes the program of study, facilities, and research activities of the staff is available from the Director of Graduate Studies.

### Courses of Instruction

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| 200. Introduction to the Physiology of Man                   | 311. Physiological Basis of Medicine                                  |
| 204. Introduction to Modern Physiology                       | 321. Gastrointestinal and Renal Physiology                            |
| 208. Respiratory System in Health and Disease                | 330. Pharmacological Basis of Clinical Medicine                       |
| 210, 211. Individual Study and Research                      | 331. Laboratory Methods in Pharmacology                               |
| 212. Membrane Physiology and Osmoregulation                  | 334. Pharmacodynamics   |
| 215. Topics in Developmental Physiology                      | 335. Drug Receptor Theory   |
| 216. Contractile Processes                                   | 362. Current Topics in Cardiac Muscle Physiology                      |
| 217. Membrane Transport                                      | 372. Research in Physiology and Pharmacology                          |
| 220. Physiology of Exercise                                  | 383. Physiological Instrumentation                                    |
| 222. Marine Electrobiolgy                                    | 386. Laboratory Methods on Electrophysiology                          |
| 225. An Introduction to Neuronal Physiology and Pharmacology | 393. Integrative and Clinical Neurophysiology                         |
| 230. Molecular and Cellular Basis of Development             | 401. Metabolic and Developmental Physiology                           |
| 230S. Seminar  | 414. Analysis of Physiological Systems                                |
| 250. Pharmacology: Mode of Action of Drugs                   | 416. Biophysics of Excitable Membranes                                |
| 252. Cellular and Chemical Pharmacology                      | 417. Cellular Endocrinology   |
| 254. Mammalian Toxicology                                    | 418. Reproductive Biology   |
| 256. Human Nutrition   | 419. Topics in Mathematical Physiology                                |
| 280. Student Seminar in Physiology and Pharmacology          | 420. Cellular Immunophysiology  |
| 281. Teaching Methods in Physiology                          | 422. Advanced Seminar in Endocrinology and Reproductive Physiology I  |
| 282. Teaching Methods in Pharmacology                        | 423. Advanced Seminar in Endocrinology and Reproductive Physiology II |

## Political Science

### Professors

James David Barber, Ph.D. (Yale), *Chairman*; Ralph Braibanti, Ph.D. (Syracuse), *James B. Duke Professor of Political Science*; Frederic N. Cleaveland, Ph.D. (Princeton); Kazimierz Grzybowski, S.J.D. (Harvard); Hugh Marshall Hall, Jr., Ph.D. (Texas); John Hamilton Hallowell, Ph.D. (Princeton); Ole R. Holsti, Ph.D. (Stanford); Jerry F. Hough, Ph.D. (Harvard); Allan Kornberg, Ph.D. (Michigan); Richard H. Leach, Ph.D. (Princeton).

### Associate Professors

Albert Eldridge, Ph.D. (Kentucky); Peter Fish, Ph.D. (Johns Hopkins); Willis F. Hawley, Ph.D. (California at Berkeley); Sheridan Johns III, Ph.D. (Harvard), *Director of Graduate Studies*; David Paletz, Ph.D. (California at Los Angeles); David E. Price, B.D., Ph.D. (Yale); Ronald L. Rogowski, Ph.D. (Princeton); Lester M. Salamon, Ph.D. (Harvard); Thomas A. Spragens, Ph.D. (Duke); Arturo Valenzuela, Ph.D. (Columbia).

### Assistant Professors

David J. Falcone, Ph.D. (Duke); Joseph J. Kruzal, Ph.D. (Harvard); Margaret A. McKean, Ph.D. (California at Berkeley); William Mishler, Ph.D. (Duke).

### Lecturers

Jean F. O'Barr, Ph.D. (Northwestern); Deborah A. Stone, Ph.D. (Massachusetts Inst. of Tech.).

The Department of Political Science offers graduate work leading to the A.M. and Ph.D. degrees. Before being admitted to candidacy for the Ph.D. degree, an applicant is normally expected to have qualified for the A.M. degree.

Instruction is designed to prepare the student for teaching and research, for government service, and for other work related to public affairs. Before undertaking graduate



study in political science, a student is ordinarily expected to have completed at least 12 semester hours of course work in political science, including some work in American government. Fields in which instruction is offered currently are American government and politics, comparative government and politics, political theory, international relations, and empirical theory and methodology.

The candidate for the degree of Doctor of Philosophy in political science must take at least twelve courses in the department and demonstrate competence in at least three general fields of the discipline as well as in a fourth general field or in a specialized sub-field or in a field external to the department. The candidate must also demonstrate a reading knowledge of two foreign languages or must demonstrate proficiency in one such foreign language and in the use of statistics.

Further details on the graduate program in political science, the departmental facilities, the staff, and available financial aid may be obtained from the Director of Graduate Studies, Department of Political Science.

### Courses of Instruction

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| 201. Arms Control and Defense Strategy  | 253. Comparative Government and the Study of Latin America        |
| 204. Ethics in Political Life   | 257S, 258S. Modern East Asia                                      |
| 206. Politics and the Media   | 260. The Tradition of Political Inquiry                           |
| 207. American Constitutional Interpretation                                   | 273S. The American South as a "Developing Society"                |
| 209. Problems in State Government and Politics                                | 274. Political Psychology   |
| 210. The Politics of Education  | 275. The American Party System                                    |
| 211S. Problems and Issues in Japanese Politics                                | 277. Comparative Party Politics                                   |
| 212. Japanese Foreign Policy  | 278. Canadian Political Behavior in the North American Context    |
| 215. Comparative Legislative Processes  | 279. The Legislative Process                                      |
| 216S. Comparative Politics of the Welfare State                               | 280. Comparative Government and Politics: Sub-Saharan Africa      |
| 217S. Economic Theories of Political Behavior                                 | 283S. Congressional Policy-making                                 |
| 218S-219S. Political Thought in the United States                             | 285. The Judicial Process   |
| 220S. Problems in International Politics                                      | 291. Problems of Urban Government                                 |
| 221. International Organization   | 293. Federalism   |
| 222. Empirical Theory   | 301. Teaching Political Science                                   |
| 223. Political Philosophy from Plato to Machiavelli                           | 303. Seminar on Selected Topics in Statistics                     |
| 224. Modern Political Theory  | 306. Seminar in Politics and the Mass Media of Communication      |
| 225. Comparative Government and Politics: Western Europe                      | 307. Graduate Seminar in American Voting Behavior                 |
| 226. Theories of International Relations                                      | 308. Individual Research in Political Science                     |
| 227. International Law  | 309. Seminar in International Relations                           |
| 229. Recent and Contemporary Political Theory                                 | 310. Seminar in State and Local Government                        |
| 230. American National Government   | 312. Seminar in Constitutional Law                                |
| 231. American Political Theory  | 313. Education and Public Policy                                  |
| 233. Research Methodology   | 321. Seminar in Political Theory                                  |
| 234S. Political Economy of Development: Theories of Change in the Third World | 322. Seminar in Selected Topics in Empirical and Formal Theory    |
| 235. The Commonwealth   | 323. Seminar in Modern Political Theory                           |
| 236. Statistical Analysis   | 325. Seminar in Comparative Government and Politics               |
| 237S. Problems in American Foreign Policy                                     | 329. Seminar in International Regional Organization               |
| 238. Comparative Foreign Policy   | 330. Seminar in Comparative Government and Politics—Southern Asia |
| 239S. Current Problems of International Law                                   | 331. Seminar in American Political Thought                        |
| 241. Public Administrative Organization and Management                        | 340. Seminar in American Politics and Institutions                |
| 243. Applications of Administrative and Organizational Theory                 | 341. Seminar in Public Administration                             |
| 244. Administrative Law and Process   | 342. Seminar in American National Government and Politics         |
| 245S. Ethics and Policy-making  | 343. Seminar in the Policy Process                                |
| 246. Administration and Public Policy   | 344. Workshop on Computer Models of Social Systems                |
| 247. Political Participation and Policy Outcomes                              |   |
| 248. The Politics of the Policy Process                                       |   |
| 249. Comparative Political Analysis and Political Development                 |   |
| 250. Comparative Government and Politics: Southern Asia                       |   |
| 252. Comparative Political Behavior and Socialization                         |   |

- 360. Seminar in Government and Politics in the Soviet Union
- 361. Seminar in Foreign Relations of the Soviet Union
- 376. Seminar in Comparative Political Behavior
- 380. Seminar in African Government and Politics
- 381. Research Seminar in Latin American Government and Politics
- 382. Soviet Law and Society
- 401. Seminar in the Commonwealth
- 402. Interdisciplinary Seminar in the History of the Social Sciences

## Psychology

### Professors

Irving Emanuel Alexander, Ph.D. (Princeton); William Bevan, Ph.D. (Duke), *William Preston Few Professor of Psychology and Chairman*; Lloyd Joseph Borstelmann, Ph.D. (California at Berkeley); Robert Charles Carson, Ph.D. (Northwestern); Irving Thomas Diamond, Ph.D. (Chicago), *James B. Duke Professor of Psychology*; Carl John Erickson, Ph.D. (Rutgers); Robert Porter Erickson, Ph.D. (Brown); Norman Guttman, Ph.D. (Indiana); Edward Ellsworth Jones, Ph.D. (Harvard); Martin Lakin, Ph.D. (Chicago); Gregory Roger Lockhead, Ph.D. (Johns Hopkins); Harold Schiffman, Ph.D. (Princeton); John Staddon, Ph.D. (Harvard), *Director of Graduate Studies*; Michael A. Wallach, Ph.D. (Harvard); Cliff Waldron Wing, Jr., Ph.D. (Tulane).

### Associate Professors

John C. Coie, Ph.D. (California at Berkeley); Robert Costanzo, Ph.D. (Florida); William C. Hall, Ph.D. (Duke); John B. McConahay, Ph.D. (California at Los Angeles).

### Assistant Professors

Carol Eckerman, Ph.D. (Columbia); Gregory W. Fischer, Ph.D. (Michigan); William Kalat, Ph.D. (Pennsylvania); Irwin Kremen, Ph.D. (Harvard); Alan S. Levy, Ph.D. (Columbia); Thomas T. Norton, Ph.D. (California at Los Angeles); G. M. Robinson, Ph.D. (Chicago); Susan Roth, Ph.D. (Northwestern).

### Lecturers

John H. Casseday, Ph.D. (Indiana); Herbert Floyd Crovitz, Ph.D. (Duke); W. Doyle Gentry, Ph.D. (Florida State); Gail R. Marsh, Ph.D. (Iowa); Ronald W. Oppenheim, Ph.D. (Washington); Talmage Lee Peele, M.D. (Duke); Susan S. Schiffman, Ph.D. (Duke); William Derek Shows, Ph.D. (Duke); George G. Somjen, M.D. (New Zealand); Lise Wallach, Ph.D. (Kansas); M. L. Wolbarsht, Ph.D. (Johns Hopkins).

The department offers work leading to the Ph.D. degree. The areas of concentration are experimental, biological, cognitive, social, personality, developmental, and clinical psychology. Students in experimental, biological, and cognitive psychology should have a strong undergraduate background in the basic sciences: mathematics, physics, biology, and chemistry.

A brochure is available from the Director of Graduate Studies which describes the program in more detail and gives information on financial assistance, facilities, and current research activity.

### Courses of Instruction

- 203. Sensation and Perception
- 206. Comparative Psychology
- 210. Cognitive Psychology
- 212. Human Memory
- 213. Adaptive Behavior
- 214, 215. Developmental Psychology
- 216. Biological Psychology
- 217. Social Psychology
- 218. Research Methods in Social Psychology
- 219. Neural Bases of Behavior
- 228. Visually Guided Behavior
- 230. Social Behavior of Animals
- 234. Seminar in Personality
- 238. Electroencephalogram and Psychological Function
- 245. Personality Theory I
- 253. Psychological Approaches to Public Policy Analysis
- 261. Science, Politics, and Government
- 2715. Selected Problems
- 273-274. Statistical Principles in Experimental Design
- 276. Neuroanatomical Basis of Sensory Physiology
- 280. Psychology as a Science
- 283, 284. The History of Psychology
- 293. Methods in Developmental Psychology
- 305. Psychopathology
- 306. Seminar in Developmental Psychology
- 307. Introduction to Methods in Psychotherapy
- 309. Seminar in Learning
- 310. Seminar in Perception

- 314. Seminar in Instrumental Behavior
- 316. Seminar in Social Psychology
- 317. Seminar in Social Behavior
- 319-320. Research Apprenticeship I
- 321. Seminar in Psychophysiology of Hearing
- 325. Seminar in Animal Behavior
- 329-330. Pro-Seminar in Psychology
- 331-332. Research Apprenticeship II
- 333, 334. Seminar: Behavioral Studies of the Brain
- 335-336. Clinical Inquiry I
- 337. Seminar in Sensory Discrimination
- 340. Group Processes and Sensitivity Training
- 341-342. Clinical Practicum
- 343, 344. Clinical Inquiry II
- 347-348. Personality Assessment
- 350. Practicum in Psychological Research
- 393. Integrative and Clinical Neurophysiology

## Public Policy Sciences

### Professors

Edward Harvey Estes, Jr., M.D. (Emory); Joel Lawrence Fleishman, LL.B. (Yale), *Director*; Jerry F. Hough, Ph.D. (Harvard); David L. Lange, LL.B. (Illinois).

### Associate Professors

Robert D. Behn, Ph.D. (Harvard); Colin C. Blaydon, Ph.D. (Harvard); Paul B. Ginsburg, Ph.D. (Harvard); Henry G. Grabowski, Ph.D. (Princeton); Willis D. Hawley, Ph.D. (California at Berkeley), *Associate Director and Director of Graduate Studies*; John B. McConahay, Ph.D. (California at Los Angeles); David E. Price, B.D., Ph.D. (Yale).

### Assistant Professors

Peter R. Decker, Ph.D. (Columbia); Gregory W. Fischer, Ph.D. (Michigan); Lawrence C. Goodwyn, Ph.D. (Texas); Bruce R. Kuniholm, Ph.D. (Duke); Joseph Lipscomb, Jr., Ph.D. (Vanderbilt); Daniel S. Nagin, Ph.D. (Carnegie-Mellon); Lester M. Salamon, Ph.D. (Harvard); Carol B. Stack, Ph.D. (Illinois); Deborah Ann Stone, Ph.D. (Massachusetts Inst. of Tech.).

### Lecturers

Bruce L. Payne, M.A. (Yale); James W. Vaupel, M.P.P. (Harvard).

The graduate program in public policy sciences is offered through the Institute of Policy Sciences and Public Affairs. The course of study consists of a series of joint degree programs leading to the degrees of Master of Arts in public policy sciences, and a doctoral or professional degree. Such a program is designed to foster in highly trained professionals the perceptual and analytical skills necessary for sound public decision-making. The Institute does not award independent A.M. or Ph.D. degrees.

With the exception of those individuals already possessing doctoral or professional degrees, therefore, all graduate students in the Institute must pursue a concurrent degree in another department or school at Duke, or at a nearby cooperating institution. Joint degree programs exist or are being developed between the Institute and the Schools of Law, Divinity, Engineering, Medicine, Environmental Management, Forestry, Business Administration, and with several graduate departments, as well as with nearby institutions.

Students usually apply for the joint degree program simultaneously with their applications to the graduate departments or professional schools, or during their first or second year of advanced study. Candidates are expected to complete an equivalent of at least one full year of work beyond that which their doctoral or professional degree would require.

The joint degree curriculum involves a minimum of ten courses, to be specified by the Institute. Academic work includes a two- to three-course research sequence and a summer internship in one of several policy areas such as law and the administration of justice, communications, health, and education. This policy-research sequence, in which the student works closely with faculty in tutorial or small group situations, stresses the development of analytical skills applicable to the broad range of policy arenas.

Further information concerning specific joint degree programs may be obtained from the Director of Graduate Studies.

### Courses of Instruction

- 204. Ethics in Political Life
- 2165. Comparative Politics of the Welfare State
- 217. Microeconomics and Public Policy-making
- 219. The Politics of the Policy Process

221. Analytical Methods I: Decision Analysis for Public Policy-makers
222. Analytical Methods II: Data Analysis for Public Policy-makers
- 223S. Ethics and Policy-making
224. Applications of Administrative and Organizational Theory
231. Analytical Methods III: Evaluation of Public Programs and Policies
232. Analytical Methods IV: Regression and Simulation Techniques for Policy Analysis
233. Analytic Approaches to Bargaining, Cooperation, and Competition
- 236S. Public Financial Management
246. Population Policy
247. Political Participation and Policy Outcomes
- 242S. National Security Policy
253. Psychological Approaches to Public Policy
254. Transportation Planning and Policy Analysis
255. Science, Politics, and Government
256. The Economics of Health Care
- 260S. Public Policy Research Seminar: The Administration of Justice
- 261S. Research Seminar: Health Policy
- 262S. Research Seminar in Communications
- 263S. Public Policy Research Seminar: Urban and Regional Development Policy
- 264S. Public Policy Research Seminar: Topics in Public Policy I
- 270S. Humanistic Perspectives on Public Policy
271. The Uses of History in Public Policy: I
272. Poverty in the United States: An Historical Perspective
273. The Uses of History in Public Policy II
274. Sanity in Society: Mental Health Policy in the United States
275. Class, Ethnicity, and Social Policy
- 283S. Congressional Policy-making
- 284S. Research Seminar in Communications Policy
301. Public Policy Workshops
302. Public Policy Workshop
- 340-390. Public Policy Research Seminars
391. Multinational Corporations Seminar

## Religion

### Professors

Frank Baker, B.D., Ph.D. (Nottingham); W. Waldo Beach, B.D., Ph.D. (Yale); David Bradley, Ph.D. (Yale); Robert E. Cushman, B.D., Ph.D., L.H.D. (Yale); William David Davies, B.D., M.A., D.D. (Wales); George Washington Ivey Professor of Advanced Studies in *New Testament and Research in Christian Origins*; Stuart C. Henry, B.D., Ph.D. (Duke); Frederick L. Herzog, Th.D. (Princeton); Creighton Lacy, B.D., Ph.D. (Yale); Thomas A. Langford, B.D., Ph.D. (Duke); C. Eric Lincoln, Ph.D. (Boston); Charles H. Long, Ph.D. (Chicago); Roland E. Murphy, S.T.D. (Catholic Univ.); Robert Osborn, B.D., Ph.D. (Drew); William H. Poteat, B.D., Ph.D. (Yale), *Chairman*; James L. Price, Jr., B.D., Ph.D. (Cambridge); D. Moody Smith, Jr., B.D., Ph.D. (Yale), *Director of Graduate Studies*; Harmon L. Smith, B.D., Ph.D. (Duke); David Curtis Steinmetz, Th.D. (Harvard); Orval Wintermute, B.D., Ph.D. (Johns Hopkins); Franklin W. Young, B.D., Ph.D. (Duke); Amos Ragan Kearns Professor of *New Testament and Patristic Studies*.

### Associate Professors

Lloyd Richard Bailey, Ph.D. (Hebrew Union); James H. Charlesworth, B.D., Ph.D. (Duke); Roger J. Corless, Ph.D. (Wisconsin); Wesley A. Kort, B.D., Ph.D. (Chicago); Bruce B. Lawrence, Ph.D. (Yale); Eric M. Meyers, Ph.D. (Harvard); Harry B. Partin, B.D., Ph.D. (Chicago); Jill Raitt, Ph.D. (Chicago); Charles K. Robinson, B.D., Ph.D. (Duke).

### Assistant Professor

Robert C. Gregg, Ph.D. (Pennsylvania).

The Department of Religion offers graduate work leading to the A.M. and Ph.D. degrees. Students may major in one of three fields: (1) Biblical studies; (2) historical studies; and (3) systematic and contemporary studies. They will be expected to take such courses in one or both of the other fields which will contribute to an adequate understanding of their chosen fields of specialization.

In addition to course work in these major fields, students will take such other courses in cognate fields as will contribute to the enrichment of their major studies. This minor requirement may be fulfilled either by work in a cognate department, such as classical studies, history, political science, or sociology, or by work in a cognate field within the Department of Religion other than the field of major concentration.

The program of doctoral studies presumes a foundation in the academic study of religion. Students applying for graduate work in religion directly from an undergraduate program should have had a strong undergraduate major in religion, and will be accepted for the Ph.D. program only upon the satisfactory completion of the A.M. degree with the department.



## BIBLICAL STUDIES

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| <p>207. Second Hebrew</p> <p>208. Second Hebrew</p> <p>209. Old Testament Theology</p> <p>220. Third Hebrew</p> <p>221. Readings in Hebrew Biblical Commentaries</p> <p>223A. Exegesis of the Hebrew Old Testament: Amos and Hosea</p> <p>223B. Exegesis of the Hebrew Old Testament: Job</p> <p>223C. Exegesis of the Hebrew Old Testament: Exodus</p> <p>223D. Exegesis of the Hebrew Old Testament: Song of Songs</p> <p>225. Living Issues in New Testament Theology</p> <p>226A. Exegesis of the Greek New Testament I (Mark and Matthew)</p> <p>226B. Exegesis of the Greek New Testament I (Romans)</p> <p>226D. Exegesis of the Greek New Testament I (I and II Corinthians)</p> <p>226E. The Gospel and Epistles of John</p> <p>227A. Exegesis of the Greek New Testament II (Luke-Acts)</p> <p>227B. Exegesis of the Greek and New Testament II (Galatians)</p> <p>227C. Exegesis of the Greek New Testament II (The Pastoral Epistles)</p> <p>237. History of the Ancient Near East</p> | <p>239. Introduction to Middle Egyptian</p> <p>242. Life After Death in Semitic Thought</p> <p>244. The Archeology of Palestine in Hellenistic-Roman Times</p> <p>258. Coptic</p> <p>302. Studies in the Intertestamental Literature</p> <p>304. Aramaic</p> <p>304A. Targumic Aramaic</p> <p>306. Language and Literature of the Dead Sea Scrolls</p> <p>307. Syriac</p> <p>311. Pharisaic Judaism in the First Century</p> <p>312. Pauline Theology</p> <p>314. Judaism and Christianity in the New Testament</p> <p>319. The Gospel According to St. Matthew in Recent Research</p> <p>323A. Comparative Semitic I</p> <p>323B. Comparative Semitic II</p> <p>340-341. Seminar in the New Testament</p> <p>345. The Epistle to the Hebrews in Recent Research</p> <p>350-351. Old Testament Seminar</p> <p>353. Seminar on Text Criticism</p> <p>373-374. Elementary Akkadian</p> <p>375-376. Elementary Ugaritic</p> <p>401. Colloquium in Biblical Studies</p> |
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## HISTORICAL STUDIES

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| <p>206. Christian Mysticism in the Middle Ages</p> <p>217. Islam in India</p> <p>218. Religion in Japan</p> <p>219. Augustine</p> <p>236. Luther and the Reformation in Germany</p> <p>238. Jewish Responses to Christianity</p> <p>241. Problems in Reformation Theology</p> <p>246. Problems in Historical Theology</p> <p>247. Readings in Latin Theological Literature</p> <p>251. The Counter-Reformation and the Development of Catholic Dogma</p> <p>260. Seminar: Wesley Studies</p> <p>280. The History of Religions</p> <p>282. Myth and Ritual</p> <p>284. The Religion and History of Islam</p> <p>285. The Vedic Tradition: Compilation and Interpretation</p> <p>286. Religious Trends in the Indian Subcontinent</p> <p>287. The Scriptures of Asia</p> <p>288. Buddhist Thought and Practice</p> | <p>296. Religion on the American Frontier</p> <p>308. Greek Patristic Texts</p> <p>313. The Apostolic Fathers</p> <p>315-316. Seminar: History of Religions</p> <p>317. Seminar in the Greek Apologists</p> <p>318. Seminar in the Greek Fathers</p> <p>324. Readings in the History of Religion</p> <p>334. Theology and Reform in the Later Middle Ages</p> <p>335. The English Church in the Eighteenth Century</p> <p>338. Calvin and the Reformed Tradition</p> <p>339. The Radical Reformation</p> <p>344. Zwingli and the Origins of Reformed Theology</p> <p>384. Religious Dissent in American Culture</p> <p>385. Religion in American Literature</p> <p>392. Historical Forms of Protestant Ethics</p> <p>395. Christian Thought in Colonial America</p> <p>396. Liberal Traditions in American Theology</p> |
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## SYSTEMATIC AND CONTEMPORARY STUDIES

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| <p>210. Contemporary British Theology</p> <p>211. Authority in Theology</p> <p>214. The Christian Doctrine of Salvation</p> <p>230. The Meaning of Religious Language</p> <p>231. Seminar in Religion and Contemporary Thought</p> <p>232. Methods in Religion and Literature</p> <p>233. Modern Narratives and Religious Meanings</p> <p>245. Ethics in World Religions</p> <p>248. The Theology of Karl Barth</p> | <p>262. Marxist Ideology and Christian Faith</p> <p>264. The Sociology of the Black Church</p> <p>265. The Religions of the West Africa Diaspora</p> <p>272. Topics in Comparative Theology</p> <p>281. Phenomenology and Religion</p> <p>292. Christian Ethics and International Relations</p> <p>300. Systematic Theology</p> <p>303. The New Hermeneutic and the Idea of History</p> |
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- 320. Theology, Power, and Justice
- 322. Nineteenth-Century European Theology
- 325. Philosophical Theology I
- 326. Philosophical Theology II
- 328. Twentieth-Century European Theology
- 352. Seminar in Christian Theology
- 360. Special Problems in Religion and Culture
- 361. Language and Biblical Criticism
- 370. Seminar in Religion and Literature
- 377. Contemporary American Dramatic Arts and Evolving Theological Forms
- 380. Existentialist Thought
- 383. Moral Theology in the Twentieth Century
- 386. Christianity in Dialogue with Other Faiths
- 388. Ethics and Medicine
- 389. Christian Ethics and Contemporary Culture
- 390. Current Problems in Christian Ethical Theory
- 394. Christianity and the State
- 397. Contemporary American Theology
- 398. Colloquium on the College and University Teaching of Religion

## Romance Languages

### Professors

Thomas Howard Cordle, Ph.D. (Yale); John Morton Fein, Ph.D. (Harvard); Wallace Fowlie, Ph.D. (Harvard); Robert Niess, Ph.D. (Minnesota); Richard Lionel Predmore, D.M.L. (Middlebury); Marcel Tetel, Ph.D. (Wisconsin), *Chairman*; Bruce W. Wardropper, Ph.D. (Pennsylvania), *William H. Wanner Professor of Romance Languages*.

### Associate Professors

Miguel Garci-Gómez, Ph.D. (Catholic Univ.); Alexander Hull, Ph.D. (Washington); Phillip Stewart, Ph.D. (Yale); Patrick R. Vincent, Ph.D. (Johns Hopkins), *Director of Graduate Studies*.

### Assistant Professor

Ernesto Caserta, Ph.D. (Harvard); Sara Melzer, Ph.D. (Chicago).

The Department of Romance Languages offers graduate work leading to the A.M., M.A.T., and Ph.D. degrees in French and Spanish. Requirements for the A.M. may be completed by submission of a thesis or by passing a comprehensive examination in the major field. It is hoped that candidates for the A.M. and Ph.D. degree will take related work in a second Romance language; however, related work may be taken in any one or two of a number of other subject areas.

In order to undertake graduate study in Romance languages, the entering student should have credit for at least 18 semester hours (or equivalent) above the intermediate level in the major language.

### FRENCH

- 210. The Structure of French
- 213. French Literature of the Seventeenth Century
- 214. The "Moralistes" of the Seventeenth Century
- 217. French Symbolism
- 219. Old French Literature
- 220. French Pre-Romantic and Romantic Poetry
- 221, 222. The Nineteenth-Century French Novel
- 224. History of the French Language
- 225. French Prose of the Sixteenth Century
- 226. French Poetry of the Sixteenth Century
- 228. French Poetry of the Twentieth Century
- 233. Contemporary French Theater
- 234. Proust
- 241, 242. French Literature of the Eighteenth Century
- 245, 246. French Literature of the Twentieth Century
- 311, 312. French Seminar
- . Graduate Reading Course

### ITALIAN

- 283. Italian Novel of the Novecento
- 284. Dante
- 285. Dante
- 288. The Renaissance

### SPANISH

- 251. The Origins of Spanish Prose Fiction
- 252. Spanish Lyric Poetry Before 1700
- 253. The Origins of the Spanish Theater
- 255, 256. Modern and Contemporary Spanish American Literature
- 257. History of the Spanish Language

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| 258. Medieval Literature                            | 262. Galdós                               |
| 259. Spanish Phonetics                              | 265. Cervantes                            |
| 260. Origins and Development of Spanish Romanticism | 266. Drama of the Golden Age              |
| 261. Nineteenth-Century Novel                       | 275, 276. Contemporary Spanish Literature |
|   | 321, 322. Hispanic Seminar                |

## ROMANCE LANGUAGES

218. The Teaching of Romance Languages

## Slavic Languages and Literatures

### Professor

Magnus J. Krynski, Ph.D. (Columbia), *Chairman*.

### Associate Professor

Bronislas de Leval Jezierski, Ph.D. (Harvard), *Director of Graduate Studies*.

The Department of Slavic Languages and Literatures offers graduate courses in Russian language and literature and limited training in the language and literature of Poland.

Students should have sufficient preparation in the Russian language to enable them to read Russian classical literature in the original.

### Courses of Instruction

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|--|--------------------|
| 201, 202. Russian Novel of the Nineteenth Century          | 207P. Preceptorial |
| 205. The Structure of Polish in Relation to Russian        | 212. Pushkin       |
| 206. Readings in Contemporary Polish Prose in the Original | 225S. Tolstoy      |
| 207. Soviet Literature and Culture                         | 227S. Gogol        |
|  | 230. Chekhov       |
|  | 230P. Preceptorial |
|  | 232. Dostoevsky    |

## Sociology

### Professors

Kurt W. Back, Ph.D. (Massachusetts Inst. of Tech.), *Chairman*; Alan C. Kerckhoff, Ph.D. (Wisconsin); George L. Maddox, Jr., Ph.D. (Michigan State); John C. McKinney, Ph.D. (Michigan State); George C. Myers, Ph.D. (Washington); Erdman B. Palmore, Ph.D. (Columbia); Alejandro Portes, Ph.D. (Wisconsin); Jack H. Preiss, Ph.D. (Michigan State); Donald F. Roy, Ph.D. (Chicago); Joel Smith, Ph.D. (Northwestern); Edward A. Tiryakian, Ph.D. (Harvard).

### Associate Professors

James S. House, Ph.D. (Michigan); Ida Simpson, Ph.D. (North Carolina at Chapel Hill); John Wilson, D.Phil. (Oxford).

### Assistant Professors

Richard T. Campbell, Ph.D. (Wisconsin), *Director of Graduate Studies*; Mark Evers, Ph.D. (Michigan); Charles Hirschman, Ph.D. (Wisconsin); Jeanne McGee, Ph.D. (Indiana); Willie Rice, Ph.D. (North Carolina at Chapel Hill).

The department offers graduate work leading to a Ph.D. degree in sociology. Before undertaking advanced work in this department, a student must have completed a minimum of 12 semester hours of approved preliminary courses in sociology, and an additional 12 semester hours in related work. Applicants for admission should submit scores on the Graduate Record Examination, especially the Aptitude Test.

Increasingly the department is concentrating its training in three programs: Sociology of Human Development; Demography and Ecology; and Social Structure and Social Change. Students who enter without having chosen a program have their first year to do so if enter-

ing with the bachelor's degree or their first semester if entering with a master's degree. Each program has its own course requirements, but all share a six course requirement covering theory (281) and methodology (295), research methods and techniques (291, 292), and statistics (293, 294). In addition, each program has an informal seminar series and expects extensive student involvement in the research activities of program faculty. All students are expected to participate for training purposes in the teaching program of the department. In order to assure some breadth of training, all students are required to take at least two departmental courses outside the specific course requirements of both their chosen program and the departmental core requirement. Two or four additional courses outside the department in related work are also required.

There is a qualifying procedure after three semesters, or equivalent, to determine whether the student can proceed to the preliminary examination. The latter is an oral examination on a written paper that reviews substantive, theoretical, and empirical aspects of a special field chosen by the student and accepted by the student's examining committee. Further details concerning the general departmental program, the three specialized programs, departmental facilities, the staff, ongoing research, and various stipends available may be obtained from the Director of Graduate Studies.

### Courses of Instruction

- |   |  |
|---|--|
| 201. Social Change                                | 294. Intermediate Statistical Analysis                               |
| 202. Social Organization                          | 295. Methodology in Sociology  |
| 225. Medical Sociology                            | 298S, 299S. Seminar in Selected Topics                               |
| 230. Social Aspects of Aging and Death            | 301. Seminar in Human Fertility                                      |
| 241. Social Stratification                        | 302. Seminar in Migration  |
| 242. The Sociology of Occupations and Professions | 325. Social Aspects of Mental Illness and Treatment                  |
| 243. Population Dynamics and Social Change        | 341. Special Problems of Complex Systems                             |
| 244. Human Ecology and Urban Systems              | 344. Workshop on Computer Models of Social Systems                   |
| 246. Population Policy                            | 345, 346. Demographic Techniques I and II                            |
| 251. The Sociology of Modernization               | 349, 350. Seminar in Selected Topics of Demography and Ecology       |
| 254. Urbanization and Social Change               | 373, 374. Social Psychological Issues in Sociology                   |
| 259. Religion and Social Change                   | 385. Seminar in Sociological Theory                                  |
| 260. Science, Technology, and Society             | 386. Seminar in Sociological Theory                                  |
| 261. Science, Politics, and Government            | 390. Seminar in Field Methods of Sociological Research               |
| 272. The Socialization Process                    | 392. Individual Research in Sociology                                |
| 275. Social Structure and Personality             | 397, 398. Seminar in Special Research                                |
| 276. Small Groups and Social Life                 | 402. Interdisciplinary Seminar in the History of the Social Sciences |
| 278. Social Structure and the Life Cycle          |  |
| 281. Seminar in Sociological Theory               |  |
| 291. Research Methods and Techniques I            |  |
| 292. Research Methods and Techniques II           |  |
| 293. Introductory Statistical Analysis            |  |

## Zoology

### Professors

Joseph R. Bailey, Ph.D. (Michigan); John D. Costlow, Jr., Ph.D. (Duke); Donald J. Fluke, Ph.D. (Yale), *Chairman*; Nichols W. Gillham, Ph.D. (Harvard); John R. Gregg, Ph.D. (Princeton); Peter H. Klopfer, Ph.D. (Yale); Daniel A. Livingstone, Ph.D. (Yale); R. Bruce Nicklas, Ph.D. (Columbia); Knut Schmidt-Nielsen, Ph.D. (Copenhagen), *James B. Duke Professor of Physiology in Zoology*; Vance A. Tucker, Ph.D. (California at Los Angeles); Stephen A. Wainwright, Ph.D. (California at Berkeley), *Director of Graduate Studies*; Karl M. Wilbur, Ph.D. (Pennsylvania), *James B. Duke Professor of Zoology*.

### Associate Professors

Richard T. Barber, Ph.D. (Stanford); John G. Lundberg, Ph.D. (Michigan); John P. Sutherland, Ph.D. (California at Berkeley); Steven Vogel, Ph.D. (Harvard); Calvin L. Ward, Ph.D. (Texas).

### Adjunct Associate Professor

Klaus Schmidt-Koenig, Ph.D. (Freiburg).



## Assistant Professors

Richard B. Forward, Ph.D. (California at Santa Barbara); David R. McClay, Ph.D. (North Carolina at Chapel Hill); H. Frederick Nijhout, Ph.D. (Harvard); Kenneth Storey, Ph.D. (British Columbia); H. Wilbur, Ph.D. (Michigan).

The Department of Zoology manages a variety of programs tailored to individual needs of students seeking A.M. or Ph.D degrees.

In general, students entering the department will be equipped to pursue advanced degrees if they have completed an undergraduate major in biology along with some formal training in college-level chemistry, mathematics, physics, and foreign languages.

Nevertheless, in recognition and support of the modern trend toward interdisciplinary research, the department is prepared to accept promising students with less orthodox academic backgrounds and is ready to encourage any student wishing to undertake a program of study leading, in effect, to an interdisciplinary degree sponsored by the department.

Thus, all students are urged to search widely in the *Bulletin of Undergraduate Instruction* and the *Bulletin of the Graduate School* for information about the intellectual resources of the University. Special attention should be given to announcements of the Departments of Anatomy, Anthropology, Biochemistry, Botany, Chemistry, Geology, History, Mathematics, Microbiology and Immunology, Philosophy, Physiology and Pharmacology, Psychology, Sociology, and Zoology; announcements of the Schools of Engineering and Forestry should also be consulted.

## Courses of Instruction

- |   |  |
|---|--|
| 201L. Animal Behavior                         | 252. Comparative Physiology                |
| 202L. Introduction to Comparative Behavior    | 254S. Fluid Flow and Living Systems        |
| 203L. Marine Ecology                          | 258L. Laboratory Research Methods          |
| 204L. Population and Community Ecology        | 260. Advanced Cell Biology                 |
| 205. Elements of Theoretical Biology          | 262L. Cytological Materials and Methods    |
| 214L. Biological Oceanography                 | 265S, 266S. Seminar in Chromosome Biology  |
| 216L. Limnology                               | 274L. Marine Invertebrate Zoology          |
| 218L. Paleobiology                            | 275L. Invertebrate Zoology                 |
| 222L. Entomology                              | 277L. Endocrinology of Marine Animals      |
| 224L. Vertebrate Natural History              | 278L. Invertebrate Embryology              |
| 229. Morphogenetic Systems                    | 280. Principles of Genetics                |
| 235. Evolutionary Systematics                 | 286. Evolutionary Mechanisms               |
| 235L. Evolutionary Systematics                | 288S. The Cell in Development and Heredity |
| 238L. Systematic Zoology                      | 295S, 296S. Seminar                        |
| 239S. Biogeography                            | 351, 352. Departmental Seminar             |
| 245. Radiation Biology                        | 353, 354. Research                         |
| 246. Physical Biology                         | 355, 356. Seminar                          |
| 250L. Physiological Ecology of Marine Animals | 360, 361. Tutorials                        |









# Bulletin of Duke University

Graduate School

1977-1978





# **Bulletin of Duke University**

**Graduate School**

**1977-1978**

**Durham, North Carolina 1977**

EDITOR  
Sharon Adler  
EDITORIAL ASSISTANT  
Elizabeth Matheson

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PHOTOGRAPHS  
Elizabeth Matheson

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# Calendar of the Graduate School

1977

## August

- 1 Monday—Final day for filing with the Graduate School Office the Statement of Intention to complete requirements for an advanced degree during the summer session. If a thesis is to be presented, the title is to be filed at the same time as the Statement of Intention.
- 12 Friday—Last day for submitting theses for advanced degrees.
- 18-19 Thursday-Friday—Final examinations for Term III.
- 19 Friday—Final date for completion of requirements for Graduate School degrees to be awarded September 1.
- 19 Friday—Term III ends.

## Academic Year 1977-1978

- 29-31 Monday-Wednesday—Registration and matriculation of all new and nonregistered returning students in the Graduate School.
- 29-31 Monday-Wednesday—Consultation with directors of graduate study concerning course programs.
- 30 Tuesday, 9:00 a.m.—English examination for foreign students, 111 Biological Sciences Building. (See chapter on Admission for section on Additional Procedures for Foreign Students.)

## September

- 6 Tuesday, 9:00 a.m.—Fall semester classes begin.
- 7 Wednesday, 4:00-6:00 p.m.—Drop/Add begins, Indoor Stadium.
- 8-9 Thursday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building.
- 12-16 Monday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building.
- 16 Friday—Final date for changes in registration which involve adding courses, provided no reduction in fees is entailed.
- 30 Friday—Final date for dropping course-seminar registration and adding equivalent units of research.

## October

- 7 Friday—Final date for changes in registration resulting from passing a preliminary examination.
- 24-25 Monday-Tuesday—Registration for spring, 1978.

## November

- 22 Tuesday, 6:00 p.m.—Thanksgiving recess begins.
- 28 Monday, 9:00 a.m.—Classes are resumed.

## December

- 7 Wednesday, 6:00 p.m.—Fall semester classes end.
- 8-13 Thursday-Tuesday—Reading period.
- 11 Sunday—Founders' Day.
- 15 Thursday—Final examinations begin.
- 21 Wednesday—Final examinations end.

1978

## January

- 4 Wednesday, 2:00 p.m.—English examination for foreign students, 309 Flowers Building. (See chapter on Admission for section on Additional Procedures for Foreign Students.)
- 6 Friday—Registration for new and nonregistered returning students.
- 9 Monday, 9:00 a.m.—Spring semester classes begin.
- 10 Tuesday, 4:00-6:00 p.m.—Drop/Add begins, Indoor Stadium.
- 11-13 Wednesday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building.
- 16-20 Monday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building.

- 20 Friday—Final date for changes in registration which involve adding courses, provided that no reduction in fees is entailed.

#### February

- 1 Wednesday—Final date for filing with the Graduate School Office the Statement of Intention of receiving an advanced degree in May. Titles of theses and dissertations are to be filed concurrently with the Statement of Intention.  
3 Friday—Final date for dropping course-seminar registration and adding equivalent units of research.  
10 Friday—Final date for change in registration resulting from passing a preliminary examination.

#### March

- 3 Friday, 6:00 p.m.—Spring recess begins.  
13 Monday, 9:00 a.m.—Classes are resumed.  
27-28 Monday-Tuesday—Registration for fall and summer, 1978.

#### April

- 3 Monday—Last day for submitting dissertations for Ph.D. and Ed.D. degrees.  
17 Monday—Last day for submitting theses for A.M., M.S., M.Ed., and M.A.T. degrees.  
17 Monday—Last day for applying to the summer session, Term I, 1978.  
17 Monday, 6:00 p.m.—Spring semester classes end.  
18-24 Tuesday-Monday—Reading period.  
25 Tuesday—Final examinations begin.

#### May

- 1 Monday—Final examinations end.  
6 Saturday—Commencement exercises begin.  
7 Sunday—Baccalaureate Services and Commencement exercises.  
12 Friday—Final date for completing application for admission to the summer session, Term II, 1978.



# University Administration

## General Administration

Terry Sanford, J.D., LL.D., D.H., L.H.D., D.P.A., *President*  
A. Kenneth Pye, LL.M., *Chancellor*  
Frederic N. Cleaveland, Ph.D., *Provost*  
Charles B. Huestis, *Vice President for Business and Finance*  
William G. Anlyan, M.D., *Vice President for Health Affairs*  
Juanita M. Kreps, Ph.D., *Vice President*  
J. David Ross, J.D., *Vice President for Institutional Advancement*  
Stephen Cannada Harward, A.B., C.P.A., *Treasurer and Assistant Secretary*  
J. Peyton Fuller, A.B., *Assistant Vice President and Corporate Controller*  
Harold W. Lewis, Ph.D., *Vice Provost and Dean of Faculty*  
John C. McKinney, Ph.D., *Vice Provost and Dean of the Graduate School*  
John M. Fein, Ph.D., *Vice Provost and Dean of Trinity College of Arts and Sciences, School of Medicine*  
Ewald W. Busse, M.D., *Associate Provost and Dean of Medical and Allied Health Education*  
Roscoe R. Robinson, M.D., *Associate Vice President for Health Affairs and Chief Executive Officer of Duke Hospital*  
Frederick C. Joerg, M.B.A., *Assistant Provost for Academic Administration*  
Anne Flowers, Ed.D., *Assistant Provost for Educational Program Development*  
William J. Griffith, A.B., *Assistant Provost and Dean of Student Affairs*  
William C. Turner, Jr., M.Div., *Assistant Provost and Dean of Black Affairs*  
Richard L. Wells, Ph.D., *Assistant Provost and Associate Dean of Trinity College of Arts and Sciences*  
Joel L. Fleishman, LL.M., *Vice Chancellor for Public Policy Education and Research; Director of Institute for Policy Sciences and Public Affairs*  
Connie R. Dunlap, A.M.L.S., *Librarian*  
William E. King, Ph.D., *University Archivist*  
Clark R. Cahow, Ph.D., *University Registrar*  
Robert N. Sawyer, Ed.D., *University Educational Planning Officer and Director of Summer Educational Programs*  
Rufus H. Powell, LL.B., *Secretary of the University*  
Charles Linn Haslam, J.D., *University Counsel*

## Graduate School Administration

John C. McKinney, Ph.D., *Dean of the Graduate School*  
William G. Katzenmeyer, Ed.D., *Associate Dean*  
Charles M. Harman, Ph.D., *Associate Dean*  
Frances C. Thomas, A.B., *Assistant Dean*  
Pauline D. Myers, *Assistant to the Dean*

## Executive Committee of the Graduate Faculty

Dean John C. McKinney

Bernard I. Duffey (Alt.)	Francis Newton (Alt.)*
Robert F. Durden	Athos Ottolenghi*
Henry A. Fairbank	George Pearsall*
Anne Flowers (Alt.)*	Ronald D. Perkins (Alt.)
Henry Grabowski*	Richard L. Predmore*
Walter R. Guild (Alt.)*	Richard B. Searles (Alt.)
William R. Krigbaum (Alt.)*	D. Moody Smith
Montrose J. Moses	John E. R. Staddon (Alt.)

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\*Term expires September, 1977.



# Graduate School Faculty

(As of October 1, 1976.)

The date denotes the first year of service at Duke University.

- A. Rashad Abdel-khalik (1975), Ph.D., Associate Professor of Business Administration  
Mohamed Bahie Abou-Donia (1975), Ph.D., Assistant Medical Research Professor of Physiology and Pharmacology  
Anne H. Adams (1971), Ed.D., Professor of Education  
Dolph O. Adams (1972), M.D., Ph.D., Associate Professor of Pathology  
Mark Adelman (1971), Ph.D., Assistant Professor of Anatomy  
Irving Alexander (1963), Ph.D., Professor of Psychology  
William K. Allard (1975), Ph.D., Professor of Mathematics  
<sup>1</sup>A. Tilo Alt (1961-65; 1967), Ph.D., Assistant Professor of German  
D. Bernard Amos (1962), M.D., James B. Duke Professor of Immunology and Experimental Surgery  
Carl Anderson (1955), Ph.D., Professor of English  
Lewis Edward Anderson (1936), Ph.D., Professor of Botany  
Nels C. Anderson (1966), Ph.D., Associate Professor of Physiology  
Peter Anderson (1974), Ph.D., Assistant Professor of Pathology  
Roger Fabian Anderson (1950), Ph.D., Professor of Forest Entomology  
Janis Antonovics (1970), Ph.D., Associate Professor of Botany  
Stanley Hersh Appel (1964-65; 1967), M.D., Associate Professor of Biochemistry  
Mahadev L. Apte (1965), Ph.D., Associate Professor of Anthropology  
John Leslie Artley (1955), D.Eng., Professor of Electrical Engineering  
Kurt W. Back (1959), Ph.D., James B. Duke Professor of Sociology  
Rodger W. Baier (1972), Ph.D., Assistant Professor of Chemistry  
Joseph Randle Bailey (1946), Ph.D., Professor of Zoology  
Lloyd Richard Bailey (1971), Ph.D., Associate Professor of Old Testament  
Frank Baker (1960), Ph.D., Professor of English Church History  
Kenneth R. Baker (1973), Ph.D., Associate Professor of Business Administration  
Steven W. Baldwin (1970), Ph.D., Associate Professor of Chemistry  
Helmy Hamdollah Baligh (1967), Ph.D., Professor of Business Administration  
Robert H. Ballantyne (1962), Ed.D., Associate Professor of Education  
James David Barber (1972), Ph.D., Professor of Political Science  
Richard T. Barber (1970), Ph.D., Associate Professor of Zoology and Associate Professor of Botany  
Robert Lloyd Barnes (1965), Ph.D., Professor of Forest Biochemistry  
Roger C. Barr (1969), Ph.D., Associate Professor of Biomedical Engineering  
Robert Charles Bartlett (1976), M.A., Professor in Physical Therapy  
Joseph Battle (1970), Ph.D., Associate Professor of Business Administration  
William Waldo Beach (1946), Ph.D., Professor of Christian Ethics  
Robert D. Behn (1973), Ph.D., Associate Professor of Policy Sciences and Lecturer in Public Systems Engineering, Civil Engineering  
Robert M. Bell (1972), Ph.D., Assistant Professor of Biochemistry  
Peter Brian Bennett (1972), Ph.D., Associate Professor of Physiology and Pharmacology  
Jan A. Bergeron (1969), V.M.D., Adjunct Assistant Professor of Anatomy  
Charles W. Bergquist (1972), Ph.D., Assistant Professor of History  
William Bevan (1974), Ph.D., William Preston Few Professor of Psychology  
<sup>2</sup>L. C. Biedenharn, Jr. (1961), Ph.D., Professor of Physics  
Alan Biermann (1974), Ph.D., Assistant Professor of Computer Science  
Darell D. Bigner (1972), M.D., Ph.D., Associate Professor of Pathology and Lecturer in Microbiology and Immunology  
William Dwight Billings (1952), Ph.D., James B. Duke Professor of Botany  
Edward George Bिल्puch (1962), Ph.D., Professor of Physics  
John A. Bittikofer (1970), Ph.D., Associate in Clinical Biochemistry  
<sup>3</sup>John O. Blackburn (1962), Ph.D., Professor of Economics  
Kalman P. Bland (1973), Ph.D., Assistant Professor of Religion

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<sup>1</sup> Sabbatical leave, fall semester, 1976.

<sup>2</sup> Leave of absence, fall semester, 1976.

<sup>3</sup> Leave of absence, fall semester, 1976.

William F. Blankley (1972), Ph.D., *Assistant Professor of Botany*  
 Mary M. Blanks (1975), M.H.A., *Assistant Professor of Health Administration*  
 Colin C. Blaydon (1975), Ph.D., *Associate Professor of Public Policy Sciences and Business Administration*  
 J. J. Blum (1962), Ph.D., *Professor of Physiology*  
 Bruce R. Bolnick (1974), Ph.D., *Assistant Professor of Economics*  
 Dani P. Bolognesi (1971), Ph.D., *Assistant Professor of Virology*  
 Celia Bonaventura (1972), Ph.D., *Assistant Medical Research Professor of Biochemistry*  
 Joseph Bonaventura (1972), Ph.D., *Assistant Medical Research Professor of Biochemistry*  
 James Alexander Boon (1974), Ph.D., *Associate Professor of Anthropology*  
 Frank Borchardt (1971), Ph.D., *Associate Professor of German*  
 Lloyd J. Borstelmann (1953), Ph.D., *Professor of Psychology*  
 Edward H. Bossen (1972), M.D., *Associate Professor of Pathology*  
 John E. Boynton (1968), Ph.D., *Associate Professor of Botany*  
 William D. Bradford (1966), M.D., *Associate Professor of Pathology*  
<sup>4</sup>David G. Bradley (1949), Ph.D., *Professor of Religion*  
 Charles Kilgo Bradsher (1939), Ph.D., *James B. Duke Professor of Chemistry*  
 Ralph Braibanti (1953), Ph.D., *James B. Duke Professor of Political Science*  
 Eleanor F. Branch (1972), Ph.D., *Associate Professor of Physical Therapy*  
 Martin Bronfenbrenner (1971), Ph.D., *William R. Kenan, Jr. Professor of Economics and Lecturer in History*  
 Earl Ivan Brown II (1960), Ph.D., *J. A. Jones Professor of Civil Engineering*  
 Montague Brown (1975), D.P.H., *Professor of Health Administration*  
 C. Edward Buckley III (1963), M.D., *Assistant Professor of Microbiology and Immunology*  
 Rebecca Buckley (1968), M.D., *Associate Professor of Immunology*  
 Louis J. Budd (1952), Ph.D., *Professor of English*  
<sup>5</sup>Donald S. Burdick (1962), Ph.D., *Associate Professor of Mathematics*  
 Peter C. Burger (1973), M.D., *Assistant Professor of Pathology*  
 Peter H. Burian (1968), Ph.D., *Assistant Professor of Classical Studies*  
 R.O. Burns (1964), Ph.D., *Professor of Microbiology*  
<sup>6</sup>Richard M. Burton (1970), D.B.A., *Associate Professor of Business Administration*

<sup>4</sup> Sabbatical leave, fall semester, 1976.

<sup>5</sup> Sabbatical Leave, spring semester, 1977.

<sup>6</sup> Sabbatical leave, academic year, 1976-1977.





- Edmund Butler (1975), Ph.D., *Assistant Professor of Mathematics*  
 Ronald Richard Butters (1967), Ph.D., *Associate Professor of English*  
 Gale H. Buzzard (1957), Ph.D., *Assistant Professor of Mechanical Engineering*  
 Edwin H. Cady (1973), Ph.D., *Andrew W. Mellon Professor in the Humanities*  
 Philip Calkins (1973), Ph.D., *Assistant Professor of History*  
 Richard T. Campbell (1974), Ph.D., *Assistant Professor of Sociology*  
 Marjory A. Cannon (1976), M.M.S., *Associate in Physical Therapy*  
 Murray Cantor (1974), Ph.D., *Assistant Professor of Mathematics*  
 Peter F. Carbone (1966), Ed.D., *Associate Professor of Education*  
 Leonard Carlitz (1932), Ph.D., *James B. Duke Professor of Mathematics*  
<sup>7</sup>Robert C. Carson (1960), Ph.D., *Professor of Psychology*  
 Reginald D. Carter (1971), Ph.D., *Assistant Professor of Physiology*  
<sup>8</sup>Matthew Cartmill (1969), Ph.D., *Associate Professor of Anatomy and Associate Professor of Anthropology*  
<sup>9</sup>William H. Cartwright (1951), Ph.D., *Professor of Education*  
<sup>10</sup>Ernesto Caserta (1970), Ph.D., *Assistant Professor of Romance Languages*  
 John H. Cassidy (1972), Ph.D., *Assistant Professor of Psychology*  
 John Cell (1962), Ph.D., *Associate Professor of History*  
 Jack B. Chaddock (1966), Sc.D., *Professor of Mechanical Engineering*  
 William Chafe (1971), Ph.D., *Associate Professor of History*  
 Jagdish Chandra (1974), Ph.D., *Adjunct Associate Professor of Mathematics*

<sup>7</sup> Sabbatical leave, fall semester, 1976.

<sup>8</sup> Sabbatical leave, June 30, 1976 through December 31, 1976.

<sup>9</sup> Sabbatical leave, spring semester, 1977.

<sup>10</sup> Sabbatical leave, academic year, 1976-1977.

- <sup>11</sup>James H. Charlesworth (1969), Ph.D., Associate Professor of Religion  
Donald B. Chesnut (1965), Ph.D., Professor of Chemistry  
Norman L. Christensen, Jr. (1973), Ph.D., Assistant Professor of Botany  
Edgar W. Clark (1963), Ph.D., Adjunct Associate Professor of Forest Entomology  
Howard G. Clark (1968), Ph.D., Professor of Biomedical Engineering and Materials Science  
Frederic N. Cleaveland (1971), Ph.D., Professor of Political Science  
Franklin H. Cocks (1972), Ph.D., Professor of Mechanical Engineering  
Kalman J. Cohen (1974), Ph.D., Distinguished Bank Research Professor and Professor of Business Administration  
John D. Coie (1968), Ph.D., Associate Professor of Psychology  
Jeffrey Jay Collins (1974), Ph.D., Assistant Professor of Microbiology
- <sup>12</sup>Joel Colton (1947), Ph.D., Professor of History  
Robert Merle Colver (1953), Ed.D., Associate Professor of Education  
Frank J. Convery (1971), Ph.D., Associate Professor of Forest Resource Economics  
Philip J. Cook (1973), Ph.D., Assistant Professor of Policy Sciences and Economics  
Thomas Howard Cordle (1950), Ph.D., Professor of Romance Languages  
Joseph M. Corless (1972), M.D., Ph.D., Assistant Professor of Anatomy  
Roger J. Corless (1970), Ph.D., Associate Professor of Religion  
Philip Robert Costanzo (1968), Ph.D., Associate Professor of Psychology  
John D. Costlow, Jr. (1959), Ph.D., Professor of Zoology  
Sheila J. Counce (1968), Ph.D., Associate Professor of Anatomy  
Peter Cresswell (1973), Ph.D., Assistant Professor of Immunology  
Herbert F. Crovitz (1963), Ph.D., Lecturer in Psychology  
Alvin L. Crumbliss (1970), Ph.D., Associate Professor of Chemistry
- <sup>13</sup>William Louis Culberson (1955), Ph.D., Professor of Botany  
J. Gaylord Cummins (1976), Ph.D., M.P.H., Visiting Associate Professor of Health Administration  
Robert Earle Cushman (1945), Ph.D., Research Professor of Systematic Theology  
David L. Cusic (1976), M.P.H., Research Associate in Health Administration  
Ronald Y. Cusson (1970), Ph.D., Associate Professor of Physics  
Charles Daniels (1970), M.D., Ph.D., Associate Professor of Pathology  
David G. Davies (1961), Ph.D., Professor of Economics  
William D. Davies (1966), D.D., George Washington Ivey Professor of Advanced Studies in New Testament and Research in Christian Origins
- <sup>14</sup>Calvin D. Davis (1962), Ph.D., Professor of History  
Lucy T. Davis (1969), Ed.D., Associate Professor of Education  
Jeffrey R. Dawson (1972), Ph.D., Assistant Professor of Immunology  
Eugene Davis Day (1962), Ph.D., Professor of Immunology and Professor of Chemistry  
Peter R. Decker, (1975), Ph.D., Assistant Professor of Policy Sciences and History  
Thomas J. Delaney (1974), M.S., Assistant Professor of Health Administration  
David C. Dellinger (1968), Ph.D., Associate Professor of Business Administration  
Frank C. DeLucia (1969), Ph.D., Associate Professor of Physics
- <sup>15</sup>Neil de Marchi (1971), Ph.D., Associate Professor of Economics  
A. Leigh DeNeef (1969), Ph.D., Associate Professor of English  
Irving Diamond (1958), Ph.D., James B. Duke Professor of Psychology, Professor of Physiology, and Lecturer in Anatomy  
Joseph Di Bona (1967), Ph.D., Associate Professor of Education  
Arif Dirlik (1971), Ph.D., Assistant Professor of History
- <sup>16</sup>Bernard I. Duffey (1963), Ph.D., Professor of English  
Kenneth Lindsay Duke (1940), Ph.D., Associate Professor of Anatomy  
Walter Nunez Duran (1974), Ph.D., Assistant Medical Research Professor of Physiology  
Robert F. Durden (1952), Ph.D., Professor of History  
George J. Dvorak (1967), Ph.D., Professor of Civil Engineering  
Elaine Martha Eckel (1974), M.A., Assistant Professor of Physical Therapy  
Carol Eckerman Ph.D., Assistant Professor of Psychology  
Jane G. Elchlepp (1960), M.D., Ph.D., Associate Professor of Pathology  
Albert Eldridge (1970), Ph.D., Associate Professor of Political Science  
Everett H. Ellinwood, Jr. (1966), M.D., Assistant Professor of Pharmacology

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<sup>11</sup> Sabbatical leave, fall semester, 1976.

<sup>12</sup> Leave of absence, September 1, 1976 through August 31, 1979.

<sup>13</sup> Sabbatical leave, fall semester, 1976.

<sup>14</sup> Sabbatical leave, fall semester, 1976.

<sup>15</sup> Leave of absence, academic year, 1976-1977.

<sup>16</sup> Sabbatical leave, spring semester, 1977.



- Ernest Elsevier (1950), M.S., *Associate Professor of Mechanical Engineering*  
 Carl Erickson (1966), Ph.D., *Professor of Psychology*  
 Harold P. Erickson (1970), Ph.D., *Associate Professor of Anatomy*  
 Robert P. Erickson (1961), Ph.D., *Professor of Psychology*  
 Jose A. Espejo (1975), Ph.D., *Assistant Professor of Business Administration*  
 E. Harvey Estes (1953), M.D., *Professor of Public Policy Sciences*  
 Evan A. Evans (1973), Ph.D., *Associate Professor of Biomedical Engineering and Assistant Professor of Experimental Orthopaedics*  
 Lawrence E. Evans (1963), Ph.D., *Associate Professor of Physics*  
 Mark Evers (1973), Ph.D., *Assistant Professor of Sociology*  
 Henry A. Fairbank (1962), Ph.D., *Professor of Physics*  
 David J. Falcone (1975), Ph.D., *Assistant Professor of Health Administration and Assistant Professor of Political Science*  
 John Morton Fein (1950), Ph.D., *Professor of Romance Languages*  
 Arthur Bowles Ferguson (1939), Ph.D., *Professor of History*  
 Oliver W. Ferguson (1957), Ph.D., *Professor of English*  
 Bernard F. Fetter (1951), M.D., *Professor of Pathology*  
 Gregory Warren Fischer (1973), Ph.D., *Assistant Professor of Policy Sciences and Psychology*  
 Peter G. Fish (1969), Ph.D., *Associate Professor of Political Science*  
 Joel Fleishman (1971), LL.M., *Professor of Law and Professor of Public Policy Sciences*  
 William H. Fletcher (1974), Ph.D., *Assistant Professor of Anatomy*  
 Anne Flowers (1972), Ed.D., *Professor of Education*  
 Donald J. Fluke (1958), Ph.D., *Professor of Zoology*  
 Lloyd R. Fortney (1964), Ph.D., *Associate Professor of Physics*  
 Richard B. Forward (1971), Ph.D., *Assistant Professor of Zoology*  
 Derrell Foster (1974), Ph.D., *Assistant Professor of Computer Science*  
 Wallace Fowlie (1964), Ph.D., *James B. Duke Professor of Romance Languages*  
 Richard G. Fox (1968), Ph.D., *Professor of Anthropology*  
 Donald E. Francisco (1976), Ph.D., *Lecturer in Civil Engineering*  
 Irwin Fridovich (1958), Ph.D., *James B. Duke Professor of Biochemistry*  
 Ernestine Friedl (1973), Ph.D., *Professor of Anthropology*  
 Zvi Friedman (1975), Ph.D., *Visiting Assistant Professor of Physics*  
 William J. Furbish (1954), M.S., *Associate Professor of Geology*  
 Thomas M. Gallie, Jr. (1954-55; 1956), Ph.D., *Professor of Computer Science*  
 Miguel Garci-Gómez (1973), Ph.D., *Associate Professor of Romance Languages*  
 Donald Eugene Gardner (1976), Ph.D., *Adjunct Assistant Professor of Physiology and Pharmacology*  
 Devendra P. Garg (1972), Ph.D., *Professor of Mechanical Engineering*  
 Raymond Gavins (1970), Ph.D., *Associate Professor of History*  
 W. Scott Gehman, Jr. (1954), Ph.D., *Professor of Psychology in Education*  
 W. Doyle Gentry (1969), Ph.D., *Lecturer in Psychology*  
 Linda K. George (1976), Ph.D., *Associate in Physical Therapy*  
 Rhett Truesdale George, Jr. (1957), Ph.D., *Assistant Professor of Electrical Engineering*  
<sup>17</sup>Gerald E. Gerber (1962), Ph.D., *Associate Professor of English*  
 Susan Gerhart (1973), Ph.D., *Assistant Professor of Computer Science*  
 Gorman Gilbert (1976), Ph.D., *Lecturer in Civil Engineering*  
 Nicholas W. Gillham (1968), Ph.D., *Professor of Zoology*  
 Paul B. Ginsburg (1976), Ph.D., *Associate Professor of Policy Sciences*  
 Kenneth E. Glander (1975), Ph.D., *Assistant Professor of Anthropology*  
 Martin P. Golding (1976), Ph.D., *Professor of Philosophy*  
 Linda R. Gooding (1974), Ph.D., *Assistant Professor of Immunology*  
 Craufurd Goodwin (1962), Ph.D., *James B. Duke Professor of Economics*  
 Lawrence C. Goodwyn (1971), Ph.D., *Associate Professor of History and Senior Research Associate in the Center for Southern Studies*  
 Walter Gordy (1946), Ph.D., LL.D., D.H.C., *James B. Duke Professor of Physics*  
 Alfred T. Goshaw (1973), Ph.D., *Assistant Professor of Physics*  
 Henry G. Grabowski (1972), Ph.D., *Professor of Economics*  
 Teresa Graedon (1975), Ph.D., *Adjunct Assistant Professor of Anthropology*  
<sup>18</sup>Daniel A. Graham (1969), Ph.D., *Associate Professor of Economics*  
 Doyle G. Graham (1970), M.D., Ph.D., *Assistant Professor of Pathology*  
 Ronald C. Greene (1958), Ph.D., *Associate Professor of Biochemistry*

<sup>17</sup> Sabbatical leave, spring semester, 1977.

<sup>18</sup> Sabbatical leave, academic year, 1976-1977.

- Joseph C. Greenfield (1962), M.D., *Assistant Professor of Physiology*  
 John R. Gregg (1957), Ph.D., *Professor of Zoology*  
 Robert C. Gregg (1974), Ph.D., *Assistant Professor of Patristic and Medieval Church History*  
 Samson R. Gross (1960), Ph.D., *Professor of Genetics and Biochemistry*  
 Kazimierz Grzybowski (1967), S.J.D., *Professor of Political Science*  
 Walter R. Guib (1960), Ph.D., *Professor of Biophysics*  
<sup>19</sup>John W. Gutknecht (1969), Ph.D., *Associate Professor of Physiology and Pharmacology*  
 William P. Gutknecht (1971), Ph.D., *Assistant Professor of Chemistry*  
 Norman Guttman (1951), Ph.D., *Professor of Psychology*  
 Robert L. Habig (1969), Ph.D., *Assistant Professor of Clinical Biochemistry*  
 Donald B. Hackel (1960), M.D., *Professor of Pathology*  
 Herbert Hacker, Jr. (1965), Ph.D., *Associate Professor of Electrical Engineering*  
 Dwight H. Hall (1968), Ph.D., *Assistant Medical Research Professor of Biochemistry*  
 Hugh Marshall Hall, Jr. (1952), Ph.D., *Professor of Political Science*  
 James Ewbank Hall (1974), Ph.D., *Assistant Professor of Physiology*  
 William C. Hall (1970), Ph.D., *Associate Professor of Anatomy and Associate Professor of Psychology*  
 John Hamilton Hallowell (1942), Ph.D., *James B. Duke Professor of Political Science*  
 William E. Hammond (1968), Ph.D., *Assistant Professor of Biomedical Engineering*  
 Moo-Young Han (1967), Ph.D., *Associate Professor of Physics*  
 Charles Morgan Harman (1961), Ph.D., *Professor of Mechanical Engineering and Materials Science*  
 Jerome S. Harris (1936), M.D., *Professor of Biochemistry*  
 Gerald Hartwig (1970), Ph.D., *Associate Professor of History*  
<sup>20</sup>Thomas M. Havrilesky (1969-70; 1971), Ph.D., *Associate Professor of Economics*  
 Hal K. Hawkins (1973), M.D., Ph.D., *Assistant Professor of Pathology*  
 Willis D. Hawley (1972), Ph.D., *Associate Professor of Policy Sciences and Political Science*  
 Milton Heath (1975), LL.B. *Adjunct Professor of Environmental Law*  
 Henry Hellmers (1965), Ph.D., *Professor of Botany and Professor of Forestry*  
 Robert William Henkens (1968), Ph.D., *Associate Professor of Chemistry*  
 Stuart C. Henry (1959), Ph.D., *Professor of American Christianity*  
 Duncan Heron (1950), Ph.D., *Professor of Geology*  
 Frederick Herzog (1960), Th.D., *Professor of Systematic Theology*  
 Robert L. Hill (1961), Ph.D., *James B. Duke Professor of Biochemistry*  
 Charles H. Hirschman (1972), Ph.D., *Assistant Professor of Sociology*  
 George H. Hitchings (1970), Ph.D., *Adjunct Professor of Pharmacology*  
 Marcus Edwin Hobbs (1935), Ph.D., *Professor of Chemistry*  
 Richard Earl Hodel (1965), Ph.D., *Associate Professor of Mathematics*  
 Charles S. Hodges, Jr. (1963), Ph.D., *Adjunct Associate Professor of Forest Pathology*  
 Irving B. Holley, Jr. (1947), Ph.D., *Professor of History*  
<sup>21</sup>Frederic B. M. Hollyday (1956), Ph.D., *Professor of History*  
 Edward W. Holmes (1974), M.D., *Assistant Professor of Medicine and Biochemistry*  
 Ole R. Holsti (1974), Ph.D., *George V. Allen Professor of Political Science*  
 Everett H. Hopkins (1961), M.A., LL.D., *Professor of Education*  
 Jerry F. Hough (1973), Ph.D., *Professor of Political Science and Policy Sciences*  
<sup>22</sup>James S. House (1970), Ph.D., *Associate Professor of Sociology*  
 John S. Hughes (1976), Ph.D., *Associate Professor of Business Administration*  
 Alexander Hull (1962), Ph.D., *Associate Professor of Romance Languages*  
<sup>23</sup>Alan S. Hurlburt (1956), Ph.D., *Professor of Education*  
 William L. Hylander (1971), Ph.D., *Associate Professor of Anatomy and Associate Professor of Anthropology*  
 Wallace Jackson (1965), Ph.D., *Associate Professor of English*  
 Boi Jon Jaeger (1972), Ph.D., *Associate Professor of Health Administration*  
 Benjamin A. Jayne (1976), Ph.D., *Professor of Forestry*  
 Peter W. Jeffs (1964), Ph.D., *Professor of Chemistry*  
 Marianna Jenkins (1948), Ph.D., *Professor of Art*  
 Robert B. Jennings (1975), M.D., *Professor of Pathology*  
 Bronislas de Leval Jezierski (1958), Ph.D., *Associate Professor of Slavic Languages and Literatures*  
 Frans F. Jöbsis (1964), Ph.D., *Professor of Physiology*

<sup>19</sup> Sabbatical leave, August 1, 1976 through February 28, 1977.

<sup>20</sup> Sabbatical leave, academic year, 1976-1977.

<sup>21</sup> Sabbatical leave, spring semester, 1977.

<sup>22</sup> Sabbatical leave, fall semester, 1976.

<sup>23</sup> Leave of absence, spring semester, 1977.

- Sheridan Johns III (1970), Ph.D., *Associate Professor of Political Science*  
 Charles B. Johnson (1956), Ed.D., *Associate Professor of Education*  
 Charles E. Johnson (1976), Ph.D., *Assistant Professor of Mechanical Engineering and Materials Science*  
 Edward A. Johnson (1963), M.D., *Professor of Physiology and Pharmacology*  
 Kurt E. Johnson (1971), Ph.D., *Assistant Professor of Anatomy*  
 Terry W. Johnson, Jr. (1954), Ph.D., *Professor of Botany*  
 William W. Johnston (1963), M.D., *Professor of Pathology*  
 William Thomas Joines (1966), Ph.D., *Associate Professor of Electrical Engineering*  
 Wolfgang Karl Joklik (1968), Ph.D., *James B. Duke Professor of Microbiology and Immunology*  
<sup>24</sup>Buford Jones (1962), Ph.D., *Associate Professor of English*  
 Edward Ellsworth Jones (1953), Ph.D., *Professor of Psychology*  
 James Kalat (1971), Ph.D., *Assistant Professor of Psychology*  
 Henry Kamin (1948), Ph.D., *Professor of Biochemistry*  
 William G. Katzenmeyer (1967), Ed.D., *Professor of Education*  
 Bernard Kaufman (1968), Ph.D., *Associate Professor of Biochemistry*  
 Richard F. Kay (1973), Ph.D., *Assistant Professor of Anatomy*  
 Thomas F. Keller (1959), Ph.D., *R. J. Reynolds Industries Professor of Business Administration*  
 Allen C. Kelley (1972), Ph.D., *Professor of Economics*  
 Alan C. Kerckhoff (1958), Ph.D., *Professor of Sociology*  
 Robert B. Kerr (1965), Ph.D., *Professor of Electrical Engineering*  
 Sung-Hou Kim (1970), Ph.D., *Associate Professor of Biochemistry*  
 Thomas DeArman Kinney (1960), M.D., *Professor of Pathology and R.J. Reynolds Industries Professor of Medical Education*  
 Norman Kirshner (1956), Ph.D., *Professor of Biochemistry*  
 Joseph Weston Kitchen, Jr. (1962), Ph.D., *Associate Professor of Mathematics*  
 Gordon K. Klintworth (1964), M.D., Ph.D., *Professor of Pathology*  
 Peter H. Klopfer (1958), Ph.D., *Professor of Zoology*  
 Kenneth R. Knoerr (1961), Ph.D., *Professor of Forest Meteorology and Associate Professor of Botany*  
 J. Mailen Kootsey (1969), Ph.D. *Assistant Medical Research Professor of Physiology and Pharmacology*  
 Hillel S. Koren (1976), Ph.D., *Assistant Professor of Immunology*  
 Allan Kornberg (1965), Ph.D., *Professor of Political Science*  
 Wesley A. Kort (1965), Ph.D., *Associate Professor of Religion*  
 David Paul Kraines (1970), Ph.D., *Associate Professor of Mathematics*  
<sup>25</sup>Nicholas Michael Kredich (1968), M.D., *Assistant Professor of Biochemistry*  
<sup>26</sup>Irwin Kremen (1963), Ph.D., *Assistant Professor of Psychology*  
 Juanita M. Kreps (1955), Ph.D., *James B. Duke Professor of Economics*  
 William R. Krigbaum (1952), Ph.D., *James B. Duke Professor of Chemistry*  
 Joseph J. Kruzel (1976), Ph.D., *Assistant Professor of Political Science*  
 Magnus Jan Krynski (1966), Ph.D., *Professor of Slavic Languages and Literatures*  
 Arthur J. Kuhn (1971), Ph.D., *Assistant Professor of Business Administration*  
 Johannes A. Kylstra (1965), M.D., Ph.D., *Associate Professor of Physiology*  
 Leon Lack (1965), Ph.D., *Professor of Pharmacology*  
 Creighton Lacy (1953), Ph.D., *Professor of World Christianity*  
 Martin Lakin (1958), Ph.D., *Professor of Psychology*  
 David J. Lang (1968), M.D., *Associate Professor of Virology in the Department of Immunology*  
 David L. Lange (1971), LL.B., *Professor of Public Policy Sciences*  
 Thomas A. Langford (1956), Ph.D., *Professor of Systematic Theology*  
 Peter K. Lauf (1968), M.D., *Associate Professor of Physiology and Assistant Professor of Immunology*  
 Dan Laughhunn (1968-75; 1976), D.B.A., *Professor of Business Administration*  
 Bruce B. Lawrence (1971), Ph.D., *Associate Professor of Religion*  
 Dewey T. Lawson (1974), Ph.D., *Assistant Professor of Physics*  
 Richard H. Leach (1955), Ph.D., *Professor of Political Science and Lecturer in Education*  
 Harold E. Lebovitz (1962), M.D., *Assistant Professor of Physiology*  
 Jack A. Lees (1971), Ph.D., *Assistant Professor of Mathematics*  
 Robert Lefkowitz (1973), M.D., *Assistant Professor of Biochemistry*  
 Stephen F. Lehane (1976), Ed.D., *Assistant Professor of Education*

<sup>24</sup> Sabbatical leave, fall semester, 1976.

<sup>25</sup> Leave of absence, September 1, 1976 through June 30, 1977.

<sup>26</sup> Sabbatical leave, spring semester, 1977.

- Jonathan Peter Leis (1974), Ph.D., *Assistant Professor of Virology*  
 Warren Lerner (1961), Ph.D., *Professor of History*  
 Alan S. Levy (1973), Ph.D., *Assistant Professor of Psychology*  
 Harry L. Levy (1975), Ph.D., *Visiting Professor in Classical Studies*  
 Nelson Levy (1974), M.D., Ph.D., *Assistant Professor of Immunology*  
 Arie Y. Lewin (1974), Ph.D., *Professor of Business Administration*  
 H. Gregg Lewis (1975), Ph.D., *Professor of Economics*  
 Harold Walter Lewis (1946), Ph.D., *Professor of Physics*  
 Sara Lichtenstein (1974), Ph.D., *Assistant Professor of Art*  
 Melvyn Lieberman (1968), Ph.D., *Associate Professor of Physiology*  
 C. Eric Lincoln (1976), Ph.D., *Professor of Sociology of Religion*  
 L. Sigfred Linderoth, Jr., (1965), M.E., *Professor of Mechanical Engineering*  
 Joseph Lipscomb, Jr. (1974), Ph.D., *Assistant Professor of Policy Sciences and Economics*  
 Paul William Lisowski (1974), Ph.D., *Assistant Professor of Physics*  
 Daniel A. Livingstone (1956), Ph.D., *Professor of Zoology*  
 Charles H. Lochmuller (1969), Ph.D., *Associate Professor of Chemistry*  
 Gregory Lockhead (1965), Ph.D., *Professor of Psychology*  
 Charles Houston Long (1974), Ph.D., *Professor of Religion*  
 William Longley (1968), Ph.D., *Associate Professor of Anatomy*  
 James S. Loos (1972), Ph.D., *Assistant Professor of Physics*  
 Donald Loveland (1973), Ph.D., *Professor of Computer Science*  
 William L. Luken, Jr., (1976), Ph.D., *Assistant Professor of Chemistry*  
<sup>27</sup>John G. Lundberg (1970), Ph.D., *Associate Professor of Zoology*  
 William S. Lynn, Jr. (1954), M.D., *Associate Professor of Biochemistry*  
 George W. Lynts (1965), Ph.D., *Associate Professor of Geology*  
 John Nelson Macduff (1956), M.M.E., *Professor of Mechanical Engineering*  
 Kenneth S. McCarty (1959), Ph.D., *Professor of Biochemistry*  
 David R. McClay (1973), Ph.D., *Assistant Professor of Zoology*  
 John B. McConahay (1974), Ph.D., *Associate Professor of Psychology and Policy Sciences*  
 Barbara P. McCool (1975), Ph.D., *Associate Professor of Health Administration*  
 Joe M. McCord (1972), Ph.D., *Assistant Medical Research Professor in Medicine and Biochemistry*  
<sup>28</sup>Ralph C. McCoy (1973), M.D., *Assistant Professor of Pathology*  
 James H. McElhaney (1973), Ph.D., *Professor of Biomedical Engineering*  
 Jeanne McGee (1974), Ph.D., *Assistant Professor of Sociology*  
 Marjorie McElroy (1970), Ph.D., *Associate Professor of Economics*  
 Philip A. McHale (1972), Ph.D., *Assistant Medical Research Professor of Physiology and Pharmacology*  
 Margaret A. McKean (1974), Ph.D., *Assistant Professor of Political Science*  
 Patrick A. McKee (1969), M.D., *Assistant Professor of Biochemistry*  
 John C. McKinney (1957), Ph.D., *Professor of Sociology*  
 Thomas J. McManus (1961), M.D., *Associate Professor of Physiology*  
 Andrew T. McPhail (1968), Ph.D., *Professor of Chemistry*  
 George L. Maddox (1960), Ph.D., *Professor of Sociology*  
 Wesley A. Magat (1974), Ph.D., *Assistant Professor of Business Administration*  
 M. Stephen Mahaley (1965), M.D., Ph.D., *Assistant Professor of Anatomy*  
 Edward P. Mahoney (1965), Ph.D., *Associate Professor of Philosophy*  
 Charles S. Maier (1976), Ph.D., *Associate Professor of History*  
 Steven F. Maier (1971), Ph.D., *Assistant Professor of Business Administration*  
 Lazaro J. Mandel (1972), Ph.D., *Assistant Professor of Physiology*  
 Peter N. Marinos (1968), Ph.D., *Professor of Electrical Engineering and Professor of Computer Science*  
 Sidney David Markman (1947), Ph.D., *Professor of Art History and Archeology*  
 Gail R. Marsh (1969), Ph.D., *Lecturer in Psychology*  
 David V. Martin (1962), Ed.D., *Associate Professor of Education*  
 Seymour Mauskopf (1964), Ph.D., *Associate Professor of History*  
 Robert Arthur Maxwell (1970), Ph.D., *Adjunct Professor of Pharmacology*  
 George Mayer (1974), Ph.D., *Adjunct Associate Professor of Materials Science*  
 Miguel A. Medina, Jr., (1976), Ph.D., *Assistant Professor of Civil Engineering*  
 Elgin W. Mellow, Jr., (1965), Ph.D., *Associate Professor of English*  
 Sara E. Melzer (1975), Ph.D., *Assistant Professor of Romance Languages*  
 Lorne Mendell (1968), Ph.D., *Associate Professor of Physiology*

<sup>27</sup> Sabbatical leave, fall semester, 1976.

<sup>28</sup> Leave of absence, July 1, 1976 through June 30, 1977.



- Daniel B. Menzel (1971), Ph.D., *Associate Professor of Pharmacology*  
Louis John Metz (1963), Ph.D., *Adjunct Associate Professor of Forest Soils*  
Richard S. Metzgar (1962), Ph.D., *Professor of Immunology*  
Johannes Horst Max Meyer (1959), Ph.D., *Professor of Physics*  
Eric M. Meyers (1969), Ph.D., *Associate Professor of Religion*  
Martin Miller (1970), Ph.D., *Associate Professor of History*  
Sara Elizabeth Miller (1973), Ph.D., *Assistant Professor of Microbiology and Immunology*  
Elliott Mills (1968), Ph.D., *Associate Professor of Physiology*
- <sup>29</sup>William Mishler (1972), Ph.D., *Assistant Professor of Political Science*  
Thomas G. Mitchell (1974), Ph.D., *Assistant Professor of Mycology, Department of Microbiology and Immunology*  
Paul L. Modrich (1976), Ph.D., *Assistant Professor of Biochemistry*  
Gerald Monsman (1965), Ph.D., *Associate Professor of English*  
John W. Moore (1961), Ph.D., *Professor of Physiology*  
Lawrence C. Moore, Jr. (1966), Ph.D., *Associate Professor of Mathematics*  
Wayne J. Morse (1974), Ph.D., *Associate Professor of Business Administration*  
Montrose J. Moses (1959), Ph.D., *Professor of Anatomy*  
Earl George Mueller (1945), Ph.D., *Professor of Art*  
Bruce J. Muga (1967), Ph.D., *Professor of Civil Engineering*  
Roland E. Murphy (1967-68; 1971), S.T.D., *Professor of Old Testament*  
Francis Joseph Murray (1960), Ph.D., *Professor of Mathematics*  
George C. Myers (1968), Ph.D., *Professor of Sociology*  
Daniel Nagin (1976), Ph.D., *Assistant Professor of Policy Sciences*  
Donald H. Namm (1974), Ph.D., *Assistant Professor of Pharmacology*  
Toshio Narahashi (1962-63; 1965), Ph.D., *Professor of Physiology*  
Sydney Nathans (1966), Ph.D., *Associate Professor of History*  
Aubrey Willard Naylor (1952), Ph.D., *James B. Duke Professor of Botany*  
Thomas H. Naylor (1964), Ph.D., *Professor of Economics and Computer Science*  
Robert H. Neilson (1975), Ph.D., *Assistant Professor of Chemistry*  
Henry Winston Newson (1948), Ph.D., *James B. Duke Professor of Physics*  
Francis Newton (1967), Ph.D., *Professor of Latin in Classical Studies*  
Charles Adam Nichol (1970), Ph.D., *Adjunct Professor of Pharmacology*  
Robert Bruce Nicklas (1965), Ph.D., *Professor of Zoology*  
Robert Niess (1972), Ph.D., *Professor of Romance Languages*  
Loren W. Nolte (1966), Ph.D., *Professor of Electrical Engineering and Professor of Biomedical Engineering*  
Thomas T. Norton (1972), Ph.D., *Assistant Professor of Psychology and Assistant Professor of Physiology*  
Yasuhiko Nozaki (1966), Ph.D., *Associate in Biochemistry*
- <sup>30</sup>Holger O. Nygard (1960), Ph.D., *Professor of English*  
John F. Oates (1967), Ph.D., *Professor of Ancient History in Classical Studies*  
William O'Barr (1969), Ph.D., *Associate Professor of Anthropology*  
Fearghus O'Foghludha (1975), Ph.D., *Adjunct Professor of Physics*  
Ronald W. Oppenheim (1973), Ph.D., *Lecturer in Psychology*
- <sup>31</sup>Robert T. Osborn (1954), Ph.D., *Professor of Religion*  
Suydam Osterhout (1959), M.D., Ph.D., *Professor of Microbiology*  
Athos Ottolenghi (1959), M.D., *Professor of Physiology and Pharmacology*  
Harry Ashton Owen, Jr. (1951), Ph.D., *Professor of Electrical Engineering*  
George M. Padilla (1965), Ph.D., *Associate Professor of Physiology*
- <sup>32</sup>David L. Paletz (1967), Ph.D., *Associate Professor of Political Science*  
Aubrey E. Palmer (1944), C.E., *Associate Professor of Civil Engineering*  
Richard A. Palmer (1966), Ph.D., *Associate Professor of Chemistry*  
Erdman B. Palmore (1967), Ph.D., *Professor of Sociology*  
Harold Talbot Parker (1939), Ph.D., *Professor of History*  
Harry B. Partin (1964), Ph.D., *Associate Professor of Religion*  
Merrell Lee Patrick (1964), Ph.D., *Associate Professor of Computer Science*  
William Bernard Peach (1951), Ph.D., *Professor of Philosophy*  
George Wilbur Pearsall (1964), Sc.D., *Professor of Mechanical Engineering*  
Talmage Lee Peele (1939), M.D., *Professor of Anatomy and Lecturer in Psychology*

<sup>29</sup> Leave of absence, academic year, 1976-1977.

<sup>30</sup> Sabbatical leave, fall semester, 1976.

<sup>31</sup> Sabbatical leave, spring semester, 1977.

<sup>32</sup> Leave of absence, academic year, 1976-1977.

- Ronald D. Perkins (1968), Ph.D., *Professor of Geology*  
David W. Peterson (1973), Ph.D., *Professor of Management Sciences*  
Olan Lee Petty (1952), Ph.D., *Professor of Education*  
Leland R. Phelps (1961), Ph.D., *Professor of German*  
Jane Philpott (1951), Ph.D., *Professor of Botany and Professor of Wood Anatomy*  
Orrin Pilkey (1965), Ph.D., *Professor of Geology*  
Theo Clyde Pilkington (1961), Ph.D., *Professor of Biomedical Engineering and Professor of Electrical Engineering*  
Colin G. Pitt (1969), Ph.D., *Adjunct Associate Professor of Chemistry*  
Robert A. Pittillo, Jr. (1968), Ed.D., *Associate Professor of Education*  
Jacques C. Poirier (1955), Ph.D., *Professor of Chemistry*  
<sup>33</sup>Ned Allen Porter (1969), Ph.D., *Associate Professor of Chemistry*  
<sup>34</sup>Alejandro Portes (1975), Ph.D., *Professor of Sociology*  
Herbert S. Posner (1968), Ph.D., *Associate Clinical Professor of Pharmacology*  
William H. Potat (1960), Ph.D., *Professor of Religion and Comparative Studies*  
Philip Pratt (1966), M.D., *Professor of Pathology*  
Richard Lionel Predmore (1950), D.M.L., *Professor of Romance Languages*  
Jack J. Preiss (1959), Ph.D., *Professor of Sociology*  
Richard A. Preston (1965), Ph.D., *William K. Boyd Professor of History*  
David Eugene Price (1973), Ph.D., *Associate Professor of Political Science and Policy Sciences*  
James Ligon Price, Jr. (1952), Ph.D., *Professor of Religion*  
Louis DuBose Quin (1957), Ph.D., *Professor of Chemistry*  
Naomi Quinn (1972), Ph.D., *Assistant Professor of Anthropology*  
Jill Raitt (1973), Ph.D., *Associate Professor of Historical Theology*  
R. Rajagopal (1974), Ph.D., *Assistant Professor of Quantitative Science*  
K. V. Rajagopalan (1966), Ph.D., *Professor of Biochemistry*  
Charles William Ralston (1954), Ph.D., *Professor of Forest Soils*  
Fidel Ramon (1974), Ph.D., *Assistant Medical Research Professor of Physiology and Pharmacology*  
Dale B. J. Randall (1957), Ph.D., *Professor of English*  
Michael Charles Reed (1974), Ph.D., *Professor of Mathematics*  
Michael Kay Reedy (1969), M.D., *Associate Professor of Anatomy*  
Keith Arnold Reimer (1975), Ph.D., M.D., *Assistant Professor of Pathology*  
Edmund Reiss (1967), Ph.D., *Professor of English*  
<sup>35</sup>Jacqueline A. Reynolds (1969), Ph.D., *Associate Professor of Biochemistry*  
<sup>36</sup>Willy E. Rice (1974), Ph.D., *Assistant Professor of Sociology*  
David Claude Richardson (1969), Ph.D., *Associate Professor of Biochemistry*  
Lawrence Richardson, Jr. (1966), Ph.D., *Professor of Latin in Classical Studies*  
Kent J. Rigsby (1971), M.A., *Assistant Professor of Classical Studies*  
Nathan Russell Roberson (1963), Ph.D., *Professor of Physics*  
George W. Roberts (1971), Ph.D., *Associate Professor of Philosophy*  
Verne Louis Roberts (1973), Ph.D., *Adjunct Professor of Mechanical Engineering*  
J. David Robertson (1966), M.D., Ph.D., *James B. Duke Professor of Anatomy*  
Charles K. Robinson (1961), Ph.D., *Associate Professor of Philosophical Theology*  
George Robinson (1971), Ph.D., *Assistant Professor of Psychology*  
Hugh G. Robinson (1964), Ph.D., *Professor of Physics*  
Herman R. Robl (1959-64; 1966), Ph.D., *Adjunct Professor of Physics*  
Ronald L. Rogowski (1975), Ph.D., *Associate Professor of Political Science*  
James L. Rolleston (1975), Ph.D., *Associate Professor of Germanic Languages and Literature*  
<sup>37</sup>Theodore Ropp (1938), Ph.D., *Professor of History*  
Gerald Martin Rosen (1972), Ph.D., *Assistant Professor of Pharmacology*  
Lawrence Rosen (1974), Ph.D., *Associate Professor of Anthropology*  
Donald Karl Rosenberg (1976), Ph.D., *Assistant Professor of Germanic Languages and Literature*  
Bruce R. Rosendahl (1976), Ph.D., *Assistant Professor of Geology*  
David Rosenthal (1968), Ph.D., *Adjunct Associate Professor of Chemistry*  
Myron Rosenthal (1969), Ph.D., *Assistant Professor of Physiology*  
David J. Ross (1972), Ph.D., *Assistant Professor of Philosophy*  
Wendell F. Rosse (1966), M.D., *Associate Professor of Immunology*  
Susan Roth (1973), Ph.D., *Assistant Professor of Psychology*

<sup>33</sup> Sabbatical leave, spring semester, 1977.

<sup>34</sup> Leave of absence, academic year, 1976-1977.

<sup>35</sup> Sabbatical leave, September 1, 1977 through August 31, 1978.

<sup>36</sup> Leave of absence, January 1, 1977 through December 31, 1977.

<sup>37</sup> Leave of absence, academic year, 1976-1977.

- Donald Francis Roy (1950), Ph.D., *Professor of Sociology*  
 Clyde de Loache Ryals (1973), Ph.D., *Professor of English*  
 Harvey J. Sage (1964), Ph.D., *Associate Professor of Biochemistry and Associate Professor of Immunology*  
 Edward A. Saibel (1975), Ph.D., *Adjunct Professor in Civil Engineering*  
 Lester M. Salamon (1973), Ph.D., *Associate Professor of Political Science and Policy Sciences*  
 John V. Salzano (1958), Ph.D., *Associate Professor of Physiology*  
 David H. Sanford (1970), Ph.D., *Associate Professor of Philosophy*  
 Lloyd Saville (1946), Ph.D., *Professor of Economics*  
 Robert N. Sawyer (1976), Ed.D., *Associate Professor of Education*  
 Saul M. Schanberg (1967), M.D., Ph.D., *Professor of Pharmacology*  
 James Howard Scheiner (1975), Ph.D., *Assistant Professor of Business Administration*  
 Harold Schiffman (1963), Ph.D., *Professor of Psychology*  
 Susan S. Schiffman (1972), Ph.D., *Lecturer in Psychology*  
 Knut Schmidt-Nielsen (1952), Mag.Sc., Ph.D., *James B. Duke Professor of Physiology in the Department of Zoology*  
 David W. Schomberg (1968), Ph.D., *Assistant Professor of Physiology*  
 James M. Schooler, Jr. (1970), Ph.D., *Assistant Professor of Physiology*  
<sup>38</sup>Anne Firor Scott (1961), Ph.D., *Professor of History*  
 David W. Scott (1971), Ph.D., *Associate Professor of Microbiology and Immunology*  
 William E. Scott (1958), Ph.D., *Professor of History*  
 Richard A. Scoville (1961), Ph.D., *Associate Professor of Mathematics*  
 Richard B. Searles (1965), Ph.D., *Associate Professor of Botany*  
 Hillard Foster Seigler (1967), M.D., *Associate Professor of Immunology*  
 Edward J. Shaughnessy, Jr. (1975), Ph.D., *Assistant Professor of Mechanical Engineering*  
 Barbara R. Shaw (1975), Ph.D., *Assistant Professor of Chemistry*  
 John Shelburne (1973), M.D., Ph.D., *Assistant Professor of Pathology*  
<sup>39</sup>Marion L. Shepard (1967), Ph.D., *Associate Professor of Mechanical Engineering*  
 Joseph R. Shoenfield (1952), Ph.D., *Professor of Mathematics*  
 William Derek Shows (1967), Ph.D., *Lecturer in Psychology*  
 Richard Shubert (1975), Ph.D., *Assistant Professor of Electrical Engineering*  
 R. Baird Shuman (1962), Ph.D., *Professor of Education*  
 James N. Siedow (1976), Ph.D., *Assistant Professor of Botany*  
<sup>40</sup>Lewis M. Siegel (1968), Ph.D., *Associate Professor of Biochemistry*  
 Sidney Arthur Simon (1974), Ph.D., *Assistant Medical Research Professor of Physiology and Pharmacology*  
 Ida Harper Simpson (1959), Ph.D., *Associate Professor of Sociology*  
 Theodore Alan Slotkin (1971), Ph.D., *Associate Professor of Physiology and Pharmacology*  
 Carol A. Smith (1974), Ph.D., *Associate Professor of Anthropology*  
 D. Moody Smith (1965), Ph.D., *Professor of New Testament Interpretation*  
 David A. Smith (1962), Ph.D., *Associate Professor of Mathematics*  
 Donald S. Smith II (1961), M.H.A., *Assistant Professor of Health Administration*  
 Grover C. Smith (1952), Ph.D., *Professor of English*  
 Harmon L. Smith (1959), Ph.D., *Professor of Moral Theology*  
 Joel Smith (1958), Ph.D., *Professor of Sociology*  
<sup>41</sup>Peter Smith (1959), Ph.D., *Professor of Chemistry*  
 Ralph E. Smith (1970), Ph.D., *Associate Professor of Microbiology and Immunology*  
 Robert Kent Smith (1975), Ph.D., *Assistant Professor and Research Associate in Physics*  
 Ralph A. Snyderman (1971), M.D., *Associate Professor of Immunology*  
 George G. Somjen (1963), M.D., *Professor of Physiology and Lecturer in Psychology*  
 Joachim R. Sommer (1957), M.D., *Professor of Pathology*  
 Madison S. Spach (1958), M.D., *Associate Professor of Physiology*  
 Thomas Arthur Spragens, Jr. (1967), Ph.D., *Associate Professor of Political Science*  
 Carol B. Stack (1975), Ph.D., *Assistant Professor of Policy Sciences and Adjunct Assistant Professor of Anthropology*  
<sup>42</sup>Olaf Stackelberg (1963), Ph.D., *Associate Professor of Mathematics*  
 John E. R. Staddon (1967), Ph.D., *Professor of Psychology*  
 William J. Stambaugh (1961), Ph.D., *Professor of Forest Pathology*

<sup>38</sup> Sabbatical leave, academic year, 1976-1977.

<sup>39</sup> Sabbatical leave, spring semester, 1977.

<sup>40</sup> Sabbatical leave, September 1, 1976 through August 31, 1977.

<sup>41</sup> Sabbatical leave, spring semester, 1977.

<sup>42</sup> Leave of absence, September 1, 1976 through August 31, 1978.

- Dennis Keith Stanley (1961), Ph.D., *Associate Professor of Classical Studies*
- <sup>43</sup>Charles Franklin Starmer, Jr., (1966), Ph.D., *Associate Professor of Computer Science*
- Howard Steinman (1972), Ph.D., *Assistant Medical Research Professor of Biochemistry*
- <sup>44</sup>David Curtis Steinmetz (1971), Th.D., *Professor of Church History and Doctrine*
- Philip Stewart (1972), Ph.D., *Associate Professor of Romance Languages*
- Alan A. Stone (1975), Ph.D., *Assistant Professor of History*
- Deborah Stone (1974), Ph.D., *Assistant Professor of Policy Sciences and Political Science*
- Donald E. Stone (1963), Ph.D., *Professor of Botany*
- <sup>45</sup>Kenneth B. Storey (1974), Ph.D., *Assistant Professor of Zoology*
- Boyd R. Strain (1969), Ph.D., *Associate Professor of Botany*
- Victor H. Strandberg (1966), Ph.D., *Associate Professor of English*
- Harold Carl Strauss (1972), M.D., *Assistant Professor of Physiology and Pharmacology*
- Timothy Lee Strickler (1973), Ph.D., *Assistant Professor of Anatomy*
- Howard Austin Strobel (1948), Ph.D., *Professor of Chemistry*
- J. Bolling Sullivan (1970), Ph.D., *Associate Professor of Biochemistry*
- <sup>46</sup>Elizabeth Read Sunderland (1939-42; 1943), Ph.D., *Professor of Art*
- <sup>47</sup>John Sutherland (1969), Ph.D., *Associate Professor of Zoology*
- <sup>48</sup>Charles Tanford (1960), Ph.D., *James B. Duke Professor of Physical Biochemistry*
- Robert Taylor (1974), Ph.D., *Assistant Professor of Business Administration*
- <sup>49</sup>John J. TePaske (1967), Ph.D., *Professor of History*
- <sup>50</sup>Marcel Tetel (1960), Ph.D., *Professor of Romance Languages*
- Fredrick L. Thurstone (1967), Ph.D., *Professor of Biomedical Engineering and Professor of Electrical Engineering*
- Edward A. Tiryakian (1965), Ph.D., *Professor of Sociology*
- Craig Tisher (1969), M.D., *Associate Professor of Pathology*
- Edward Tower (1974), Ph.D., *Associate Professor of Economics*
- <sup>51</sup>Vladimir G. Trembl (1967), Ph.D., *Professor of Economics*
- Kishor S. Trivedi (1975), Ph.D., *Assistant Professor of Computer Science*
- Yuet Tsui (1975), Ph.D., *Assistant Professor of Civil Engineering*
- Vance Tucker (1964), Ph.D., *Professor of Zoology*
- <sup>52</sup>Arlin Turner (1953), Ph.D., *James B. Duke Professor of English*
- Richard L. Tuthill (1953), Ed.D., *Professor of Economic Geography*
- Lee E. Tyrey (1970), Ph.D., *Assistant Professor of Anatomy*
- <sup>53</sup>Senol Utku (1970), Sc.D., *Professor of Civil Engineering*
- Arturo Valenzuela (1970), Ph.D., *Associate Professor of Political Science*
- Thomas C. Vanaman (1970), Ph.D., *Associate Professor of Microbiology and Immunology*
- James H. Vander Weide (1972), Ph.D., *Assistant Professor of Management Sciences*
- John M. Vernon (1966), Ph.D., *Professor of Economics*
- Aleksandar Sedmak Vesic (1964), D.Sc., *J. A. Jones Professor of Civil Engineering*
- <sup>54</sup>P. Aarne Vesilind (1970), Ph.D., *Associate Professor of Civil Engineering and Associate Professor of Environmental Studies*
- Elia E. Villanueva (1969), M.A., *Associate Professor of Physical Therapy*
- Patrick R. Vincent (1954), Ph.D., *Associate Professor of Romance Languages*
- F. Stephen Vogel (1961), M.D., *Professor of Pathology*
- Steven Vogel (1966), Ph.D., *Associate Professor of Zoology*
- Robin T. Vollmer (1975), M.D., *Assistant Professor of Pathology*
- Olaf T. von Ramm (1974), Ph.D., *Assistant Professor of Biomedical Engineering*
- Fred M. Vukovich (1967), Ph.D., *Adjunct Associate Professor of Forest Meteorology*
- Howard C. Wachtel (1968), Ph.D., *Associate Professor of Biomedical Engineering and Assistant Professor of Physiology*
- Stephen A. Wainwright (1964), Ph.D., *Professor of Zoology*

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<sup>43</sup> Leave of absence, July 1, 1976 through June 30, 1977.

<sup>44</sup> Leave of absence, spring semester, 1977.

<sup>45</sup> Leave of absence, September 1, 1976 through August 31, 1977.

<sup>46</sup> Sabbatical leave, spring semester, 1977.

<sup>47</sup> Sabbatical leave, January 1, 1976 through December 31, 1976.

<sup>48</sup> Sabbatical leave, academic year, 1977-78.

<sup>49</sup> Leave of absence, academic year, 1976-1977.

<sup>50</sup> Sabbatical leave, spring semester, 1977.

<sup>51</sup> Sabbatical leave, academic year, 1976-1977.

<sup>52</sup> Leave of absence, spring semester, 1977.

<sup>53</sup> Sabbatical leave, spring semester, 1977.

<sup>54</sup> Sabbatical leave, spring semester, 1977.



- William D. Walker (1971), Ph.D., *Professor of Physics*  
 Andrew G. Wallace (1964), Ph.D., *Assistant Professor of Physiology*  
 Thomas Dudley Wallace (1974), Ph.D., *Professor of Economics*  
 Lise Wallach (1970), Ph.D., *Lecturer in Psychology*  
 Michael Wallach (1962-72; 1973), Ph.D., *Professor of Psychology*  
 Richard L. Walter (1962), Ph.D., *Professor of Physics*  
 Paul P. Wang (1968), Ph.D., *Professor of Electrical Engineering*  
<sup>55</sup>Calvin L. Ward (1952), Ph.D., *Associate Professor of Zoology*  
 Frances Ellen Ward (1969), Ph.D., *Associate Professor of Microbiology and Immunology*  
<sup>56</sup>Bruce W. Wardropper (1962), Ph.D., *William Hanes Wannamaker Professor of Romance Languages*  
 Dennis B. Warner (1973), Ph.D., *Adjunct Assistant Professor of Civil Engineering*  
 Seth L. Warner (1955), Ph.D., *Professor of Mathematics*  
 David Grant Warren (1975), J.D., *Professor of Health Administration*  
 Richard Lyness Watson, Jr. (1939), Ph.D., *Professor of History*  
 Katharine Way (1968), Ph.D., *Adjunct Professor of Physics*  
<sup>57</sup>Robert E. Webster (1970), Ph.D., *Professor of Biochemistry*  
 Eliot Roy Weintraub (1970), Ph.D., *Professor of Economics*  
 Morris Weisfeld (1967), Ph.D., *Professor of Mathematics*  
 Henry Weitz (1950), Ed.D., *Professor of Education*  
 Richard L. Wells (1962), Ph.D., *Professor of Chemistry*  
<sup>58</sup>Paul Welsh (1948), Ph.D., *Professor of Philosophy*  
 Robert A. Westbrook (1975), Ph.D., *Assistant Professor of Business Administration*  
 Robert W. Wheat (1958), Ph.D., *Professor of Microbiology and Assistant Professor of Biochemistry*  
 Richard A. White (1963), Ph.D., *Professor of Botany*  
 Henry M. Wilbur (1973), Ph.D., *Assistant Professor of Zoology*  
<sup>59</sup>Karl Milton Wilbur (1946), Ph.D., *James B. Duke Professor of Zoology*  
 Robert L. Wilbur (1957), Ph.D., *Professor of Botany*  
 Pelham Wilder, Jr. (1949), Ph.D., *Professor of Chemistry*  
 Hilda Pope Willett (1948), Ph.D., *Professor of Bacteriology*  
 George W. Williams (1957), Ph.D., *Professor of English*  
 Leland H. Williams (1970), Ph.D., *Adjunct Associate Professor of Computer Science*  
<sup>60</sup>William Hailey Willis (1963), Ph.D., *Professor of Greek in Classical Studies*  
<sup>61</sup>James F. Wilson (1967), Ph.D., *Associate Professor of Civil Engineering*  
 John Wilson (1968), Ph.D., *Associate Professor of Sociology*  
 Thomas George Wilson (1959), Sc.D., *Professor of Electrical Engineering*  
 Wilkie Andrew Wilson, Jr. (1974), Ph.D., *Associate in Physiology and Pharmacology*  
 Cliff W. Wing, Jr. (1965), Ph.D., *Professor of Psychology*  
 Orval S. Wintermute (1958), Ph.D., *Professor of Religion and Lecturer in Old Testament*  
 Ronald Witt (1971), Ph.D., *Associate Professor of History*  
 Benjamin Wittels (1961), M.D., *Professor of Pathology*  
 Myron L. Wolbarsht (1968), Ph.D., *Adjunct Professor of Biomedical Engineering, Associate Professor of Physiology, and Lecturer in Psychology*  
<sup>62</sup>Peter H. Wood (1975), Ph.D., *Associate Professor of History*  
 Max A. Woodbury (1966), Ph.D., *Professor of Computer Science*  
 Donald Wright (1967), Ph.D., *Associate Professor of Mechanical Engineering*  
 Chau H. Wu (1975), Ph.D., *Assistant Medical Research Professor of Physiology and Pharmacology*  
 James E. Wuenscher (1970), Ph.D., *Assistant Professor of Forest Ecology*  
 Allen M. Wyse (1974), Ph.D., *Assistant Professor of Economics*  
 David O. Yandle (1967), Ph.D., *Associate Professor of Forest Mathematics*  
 June-Zoo Yeh (1975), Ph.D., *Assistant Medical Research Professor of Physiology and Pharmacology*  
 William P. Yohe (1958), Ph.D., *Professor of Economics*  
 Charles R. Young (1954), Ph.D., *Professor of History*  
 Franklin W. Young (1944-50; 1968), Ph.D., *Amos Ragan Kearns Professor of New Testament and Patristic Studies*

<sup>55</sup> Sabbatical leave, fall semester, 1976.

<sup>56</sup> Sabbatical leave, fall semester, 1976.

<sup>57</sup> Sabbatical leave, July 1, 1977 through June 30, 1978.

<sup>58</sup> Sabbatical leave, spring semester, 1977.

<sup>59</sup> Sabbatical leave, spring semester, 1977.

<sup>60</sup> Sabbatical leave, spring semester, 1977.

<sup>61</sup> Sabbatical leave, fall semester, 1976.

<sup>62</sup> Leave of absence, academic year, 1976-1977.

- John G. Younger (1974), Ph.D., *Assistant Professor of Classical Studies*  
<sup>63</sup>Julie H. Zalkind (1973), Ph.D., *Assistant Professor of Business Administration*  
 Peter Zwadyk, Jr. (1971), Ph.D., *Associate Professor of Pathology and Microbiology*  
 Hans J. Zweerink (1970), Ph.D., *Associate Professor of Microbiology and Immunology*

## Emeritus Professors

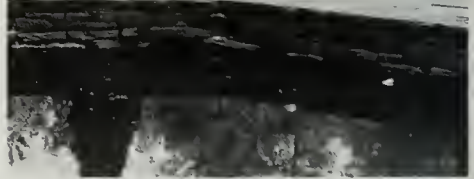
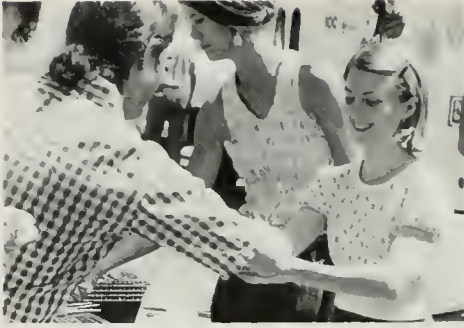
- Francis Dorothy Acomb (1945), Ph.D., *Professor Emeritus of History*  
 John Richard Alden (1955), Ph.D., *James B. Duke Professor Emeritus of History*  
 M. Margaret Ball (1963), Ph.D., *Professor Emeritus of Political Science*  
 Katharine May Banham (1946), Ph.D., *Associate Professor Emeritus of Psychology*  
 Joseph W. Beard (1937), M.D., *James B. Duke Professor Emeritus of Surgery; Professor Emeritus of Virology*  
 Frederick Bernheim (1930), Ph.D., *James B. Duke Professor Emeritus of Pharmacology*  
 Mary L. C. Bernheim (1930), Ph.D., *Professor Emeritus of Biochemistry*  
 Edward Claude Bolmeier (1948), Ph.D., *Professor Emeritus of Education*  
 Cazlyn Green Bookhout (1935), Ph.D., *Professor Emeritus of Zoology*  
 Francis Ezra Bowman (1945), Ph.D., *Professor Emeritus of English*  
 Benjamin Boyce (1950), Ph.D., *James B. Duke Professor Emeritus of English*  
 Frances Campbell Brown (1931), Ph.D., *Professor Emeritus of Chemistry*  
 Benjamin Guy Childs (1924), M.A., *Professor Emeritus of Education*  
 Kenneth Willis Clark (1931), Ph.D., D.D., *Professor Emeritus of New Testament*  
 Robert Taylor Cole (1935), Ph.D., *James B. Duke Research Professor Emeritus of Political Science*  
 Norman Francis Conant (1935), Ph.D., *James B. Duke Professor Emeritus of Microbiology*  
 Frederick A. G. Cowper (1918), Ph.D., *Professor Emeritus of Romance Languages*  
 John S. Curtiss (1945), Ph.D., *James B. Duke Professor Emeritus of History*  
 Bingham Dai (1943), Ph.D., *Professor Emeritus of Psychology and Mental Hygiene*  
 Gifford Davis (1930), Ph.D., *Professor Emeritus of Romance Languages*  
 Frank Traver de Vyver (1935), Ph.D., *Professor Emeritus of Economics*  
 Neal Dow (1934), Ph.D., *Professor Emeritus of Romance Languages*  
 Francis George Dressel (1929), Ph.D., *Professor Emeritus of Mathematics*  
 George Sharp Eadie (1930), Ph.D., *Professor Emeritus of Physiology and Pharmacology*  
 Howard Easley (1930), Ph.D., *Associate Professor Emeritus of Education*  
 William Whitfield Elliott (1925), Ph.D., *Professor Emeritus of Mathematics*  
 John Wendell Everett (1932), Ph.D., *Professor Emeritus of Anatomy*  
 Allan H. Gilbert (1920), Ph.D., *Professor Emeritus of English*  
 Sherwood Githens (1962), Ph.D., *Professor Emeritus of Education*  
 Clarence Gohdes (1930), Ph.D., *James B. Duke Professor Emeritus of English*  
 Irving Emery Gray (1930), Ph.D., *Professor Emeritus of Zoology*  
 Paul M. Gross (1919), Ph.D., *William Howell Pegram Professor Emeritus of Chemistry*  
 Louise Hall (1931), Ph.D., *Professor Emeritus of Architecture*  
 Frank A. Hanna (1948), Ph.D., *Professor Emeritus of Economics*  
 William S. Heckscher (1966), Ph.D., *Benjamin N. Duke Professor Emeritus of Art*  
 Jay Broadus Hubbell (1927), Ph.D., *Professor Emeritus of English*  
 Wanda S. Hunter (1947), Ph.D., *Associate Professor Emeritus of Zoology*  
 William H. Irving (1936), Ph.D., *Professor Emeritus of English*  
 Brady Rimbey Jordan (1927), Ph.D., *Professor Emeritus of Romance Languages*  
 Helen L. Kaiser (1943), R.P.T., *Professor Emeritus of Physical Therapy*  
 Van Leslie Kenyon, Jr. (1945), M.M.E., *Professor Emeritus of Mechanical Engineering*  
 Paul Jackson Kramer (1931), Ph.D., *James B. Duke Professor Emeritus of Botany*  
 Wladyslaw W. Kulski (1963), LL.D., *James B. Duke Professor Emeritus of Russian Affairs*  
 Weston LaBarre (1946), Ph.D., *James B. Duke Professor Emeritus of Anthropology*  
 Charles Earl Landon (1926), Ph.D., *Professor Emeritus of Economics*  
 John L. Lievsay (1962), Ph.D., *James B. Duke Professor Emeritus of English*  
 Alan Krebs Manchester (1929), Ph.D., *Professor Emeritus of History*  
 Glenn Robert Negley (1946), Ph.D., *Professor Emeritus of Philosophy*  
 Walter McKinley Nielsen (1925), Ph.D., *James B. Duke Professor Emeritus of Physics*  
 James G. Osborne (1961), B.S., *Professor Emeritus of Forest Biometry*  
 Robert Leet Patterson (1945), Ph.D., *Professor Emeritus of Philosophy*  
 Lewis Patton (1926), Ph.D., *Professor Emeritus of English*  
 Michael I. Pavlov (1960), Ph.D., *Associate Professor Emeritus of Russian*

<sup>63</sup> Leave of absence, academic year, 1976-77.

Harold Sanford Perry (1932), Ph.D., *Professor Emeritus of Botany*  
 Ray C. Petry (1937), Ph.D., LL.D., *James B. Duke Professor Emeritus of Church History*  
 Mabel F. Rudisill (1948), Ph.D., *Associate Professor Emeritus of Education*  
 Herman Salinger (1955), Ph.D., *Professor Emeritus of Germanic Languages and Comparative Literature*  
 Charles Richard Sanders (1937), Ph.D., *Professor Emeritus of English*  
 William H. Simpson (1930), Ph.D., *Professor Emeritus of Political Science*  
 David Tillerson Smith (1930), M.D., Litt.D., *James B. Duke Professor Emeritus of Microbiology*  
 H. Shelton Smith (1931), Ph.D., *James B. Duke Professor Emeritus of American Religious Thought*  
 Joseph John Spengler (1934), Ph.D., *James B. Duke Professor Emeritus of Economics*  
 William Franklin Stinespring (1936), Ph.D., *Professor Emeritus of Old Testament and Semitics*  
 W. A. Stumpf (1948), Ph.D., *Professor Emeritus of Education*  
 Edgar Tristram Thompson (1935), Ph.D., *Professor Emeritus of Sociology*  
 James Nardin Truesdale (1930), Ph.D., *Professor Emeritus of Greek*  
 Warren Chase Vosburgh (1928), Ph.D., *Professor Emeritus of Chemistry*  
 Bruce A. Wells (1964), M.S.E.E., *Associate Professor Emeritus of Electrical Engineering*  
 Robert Hilliard Woody (1929), Ph.D., *Professor Emeritus of History*









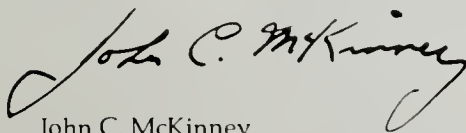
### To the Prospective Graduate Student at Duke University

Several years ago a committee of distinguished scholars was appointed and asked to appraise the state of graduate education at Duke University and indicate guidelines for its future development. I would like to quote briefly from the preamble of their report.

The primary role of a university is to provide a focus for the growth of ideas. Since ideas grow in the minds of men, communication between scholars, between faculty and students—in short, teaching—is the first basic function of a university. But without great ideas to communicate—ideas old and new, traditional and nascent—teaching is an exercise of futility. Therefore, the second basic function of a university must be research, characterized by the spirit of free inquiry and the exploration, analysis, and synthesis of ideas. These two faces of a university are complementary.

Even in the undergraduate college or in the professional school, the student learns best when moved by a spirit indistinguishable from the mood of the scholar engaged in original research. The ideas taught are, in fact, new to the student and therefore fit material for his “original” research. But it is in the graduate school that teaching and research become truly inseparable.

To the student in search of a superior graduate education Duke University has much to offer: excellent research facilities such as an outstanding library, a major computing center, modern laboratories—but above all, a highly productive graduate faculty dedicated to the twin functions of teaching and research. The following pages, and the information they contain, are addressed to the student seeking a soundly based graduate education.

A handwritten signature in dark ink, reading "John C. McKinney". The signature is fluid and cursive, with a large, sweeping initial "J" and a stylized "M".

John C. McKinney  
*Dean of the Graduate School*

# Program Information





## Degrees Offered

The Graduate School of Duke University now offers the following degrees: Master of Arts (A.M.), Master of Science (M.S.), Master of Education (M.Ed.), Master of Arts in Teaching (M.A.T.), Master of Health Administration (M.H.A.), Doctor of Philosophy (Ph.D.), and Doctor of Education (Ed.D.).

## The Master's Degrees

To be considered as a candidate for a master's degree (A.M., M.S., M.Ed., M.A.T., M.H.A.), the graduate student must (1) have made passing grades in the first 12 units of course work, (2) have made a grade of *C* or *E* on at least 3 units of this work, and (3) have received the approval of the major department (or, in the case of the M.A.T. degree, of the supervisory committee).

**Residence Requirements.** Candidates for all master's degrees must spend, as a *minimum*, one full academic year (two successive semesters), or its equivalent in summer session terms, in residence at Duke University. Candidates who wish to complete their degrees wholly in the summer session must be in residence for a minimum of five summer terms. Additional time is frequently necessary. Three terms are held each summer. (See section on Residence under Academic Regulations.)

**Transfer of Graduate Credits.** A maximum of 6 units of graduate credit may be transferred for graduate courses completed at other institutions. Such units will be transferred only if the student has received a grade of *B* (or its equivalent) or better. *In any case, the transfer of graduate credit does not reduce the required minimum registration for a master's degree at Duke.* Students who wish to transfer up to 6 units into their programs must register at Duke for units equivalent to the number they are transferring. Requests for transfer should be submitted on the approved graduate school form (T1).

A student who is granted such transfer credit may be permitted to register for as much as 12 units of thesis research instead of the usual 6 units. As another option, students may take as many as 6 units of further undergraduate training or 6 units of required language courses on the undergraduate level. In no case will credit be allowed for extension or correspondence courses.

Credit for graduate courses taken at Duke by students (not undergraduates) before their admission to the Graduate School or while registered as nondegree students may be carried over into graduate degree programs if: (1) the action is recommended by the directors of graduate studies of the departments and approved by the Dean, (2) the work is not more than two years old, (3) the amount of such credit does not exceed 6 units, and (4) the work is of G level or better.

**Time Limits for Completion of Master's Degrees.** Master's degree candidates who are in residence for consecutive academic years should complete all requirements for the degree *within two calendar years* from the date of their first registration in the Graduate School. Candidates must complete all requirements *within six calendar years of their first registration*.

To be awarded a degree in May, the student must have completed all requirements, including the recording of transfer credit, by the last day of the final examination period. If a thesis is one of the requirements, it must be submitted to the Graduate School Office no later than April 15. Candidates desiring to have their degrees conferred on September 1 must have completed all requirements, including the recording of transfer of credit, by the final day of the Duke University summer session. Candidates completing degree requirements after that date and during the fall semester will have their degrees conferred on December 30.

**The Thesis.** The thesis should demonstrate the student's ability to collect, arrange, interpret, and report pertinent material on a research problem. Although a publishable document is not required, the thesis must be written in an acceptable style and should exhibit the student's competence in scholarly procedures. Requirements of form are set forth in the *Duke University Guide for the Preparation of Theses and Dissertations*, copies of which are available in the Graduate School Office.

**Recommendation for Teacher Certification.** Elementary school teachers who already hold certificates and who desire the recommendation of Duke University for graduate teaching certificates must include in their programs a minimum of 12 units in subjects ordinarily taught in elementary school and 12 units in education courses appropriate to their professional development. Secondary school teachers must include in their programs a minimum of 18 units in their teaching fields and 6 units in courses in education appropriate to their professional development.

## MASTER OF ARTS

The Master of Arts degree may be earned either with or without presentation of a thesis. Certain general requirements must be met, however, whether or not the thesis is written.

**Prerequisites.** As a prerequisite to graduate study in the major subject, a student must have completed a minimum of 24 semester hours—ordinarily 12 semester hours of approved college courses in the major subject and 12 additional semester hours in the major or in related work. Since some departments require more than 12 semester hours in the proposed field of study, students should read carefully the special requirements listed by their major departments, described in the chapter on Courses of Instruction in this *Bulletin*. If special master's degree requirements are not specified in this section, a prospective student should write directly to the appropriate director of graduate studies.

**Language Requirements.** The Graduate School requires no foreign language for the master's degree. Certain departments, however, do have a foreign language requirement for their master's programs. Any such requirement must be satisfied before the master's examination is taken. (See the departmental sections in the



chapter on Courses of Instruction and the chapter on Registration and Regulations.)

**Major and Related Subjects.** The student must present acceptable grades for a minimum of 24 units of graduate courses. Of these, at least 12 units must be in the major subject. A minimum of 6 units must be in a minor subject or in related fields which are approved by the student's major department. The remaining 6 units of the required 24 may be taken in either the major or in related fields approved by the major department and by the Dean of the Graduate School. A maximum of 6 units may be earned either by submission of an approved thesis, or by completing courses or other academic activities approved by the student's department (see below). Thirty units of graduate credit at Duke constitutes minimum enrollment for the Master of Arts degree.

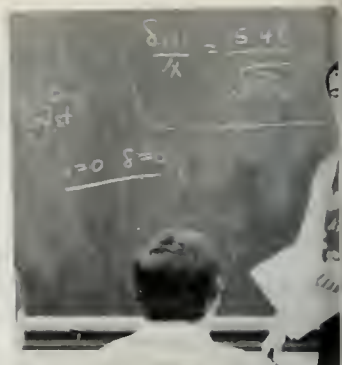
**Completing the Program with Thesis.** All basic requirements for preparing the thesis are described in the *Guide for the Preparation of Theses and Dissertations*, available in the Graduate School Office.

Four typewritten copies of the thesis bound in snap binders, which may be secured through the Graduate School Office, must be submitted in an approved form to the Dean of the Graduate School on or before April 15 for a May degree, one week before the final day of the Duke University third summer session for a September degree, one week before the final day of the fall semester for a December degree, and at least one week before the scheduled date of the final examination. The copies then will be distributed by the student to the several members of the examining committee. Two copies for the library and one copy for the adviser will be bound upon payment of \$5.50 per volume. Additional copies may be bound at the \$5.50 per volume rate.

**Completing the Program without Thesis.** Individual departments decide the options with which a Master of Arts degree may be completed without presentation of a thesis. The student's committee usually outlines the requirements for a degree program after the student has completed at least 9 units of graded course work. Beyond the 24 units required in major or related course work, 6 units may be earned either through course work or through other academic activities approved by the student's department and committee. Such academic exercises might include an additional 3 units of graded course work complemented, for example, by the following: (1) passing an oral examination on a three- to five-page research prospectus, plus a substantial bibliography on a topic within the student's major field, or (2) submission to the committee of two carefully revised term papers, preferably written originally for different instructors and earning a grade of G or higher. In any case, the student's total minimum registration will be for 30 units of graduate credit followed by a final examination (see below).

**The Examining Committee and the Examination.** The faculty member who directs the student's program chairs the examining committee and recommends for membership on the committee two other members of the graduate faculty, one of whom usually must be from a department other than the major department. If the student has been permitted to take related work within the major department, the third member may be chosen from within the department. Nominations for membership on this committee are submitted for approval to the Dean of the Graduate School at least one week preceding the final examination.

The committee will conduct the examination and certify the student's success or failure by signing the card provided by the Graduate School Office. This card indicates completion of all requirements for the degree. If a thesis is presented, the committee members also sign all copies of the thesis, and the candidate then returns the original, the first two copies, and any other copies which are to be bound to the Graduate School Office.



**Filing the Intention to Graduate.** On or before *February 1* for a May degree, on or before *August 1* for a September degree, or on or before *December 1* for a December degree, and least one month prior to the final examination, the student must file in the Office of the Graduate School, on the official form, a declaration of intention to graduate. The declaration of intention presents the title of the thesis or specifies alternative academic exercises on which the degree candidate will be examined. The declaration must have the approval of both the director of graduate studies in the major department and the chairman of the student's advisory committee.

## MASTER OF SCIENCE

The degree of Master of Science is offered in various areas, including the following: botany, forestry, geology, pathology, physical therapy, statistics and computing, and four fields of engineering—biomedical, civil, electrical, and mechanical.

**Prerequisites.** A bachelor's degree is a prerequisite for the M.S. degree. Departments offering an M.S. degree consider for admission students from allied fields provided they have satisfactory scientific and mathematical backgrounds.

**Language Requirement.** There is no foreign language requirement in Master of Science degree programs.

**Other Degree Requirements.** Specific requirements vary according to the department. Please consult the chapter on Courses of Instruction for departmental in-



formation concerning prerequisites, minimum units required, and major and related work.

**Thesis and Examination.** Some departments require a thesis; all departments require an examination. The regulations and options for theses and other means of completing the program, as well as the provisions for examination and the examining committee, are the same as the requirements for the Master of Arts degree discussed in the previous section.

## MASTER OF EDUCATION

**Prerequisites.** The M.Ed. degree is designed for persons intending to pursue a career in professional education. No specific undergraduate major is required for acceptance into a graduate program leading to this degree, but a bachelor's degree in an undergraduate program related to the student's professional goals is required.

Before the degree is conferred, a student must have completed one year of experience in professional education; have completed 6 units of practicum, internship, and or field experience; or have met certification requirements by supervised student teaching in an accredited school.

**Major and Related Subjects.** The student must present acceptable grades for a minimum of 24 units of graduate courses. Of these, at least 12 units must be in a departmental major (administration, supervision, counseling, elementary education, secondary education, higher education, reading, teaching the emotionally disturbed, or other approved programs offered by the department). A minimum of 6 units must be in a minor subject or in related areas within the Department of Edu-



cation. The remaining 6 units of the required 24 may be taken in either the major or in related subjects. The nature of the additional 6 units for which students must register depends on whether they are enrolled in thesis or non-thesis programs; i.e., the additional 6 units may be earned either by submitting an acceptable thesis or by completing courses in major and related subjects. A minimum of 30 units of earned credit is required for the degree.

**Completing the Program with Thesis.** The regulations governing the thesis are the same as those for the A.M. degree.

**Completing the Program without Thesis.** Students must pass comprehensive examinations on their departmental majors no sooner than the end of the terms in which they complete their course work. The examination shall be prepared and conducted by members of the faculty as designated by the Director of Graduate Studies of the Department of Education.

## MASTER OF ARTS IN TEACHING

**Prerequisites.** The M.A.T. degree is designed for teachers already in service and for recent graduates of liberal arts colleges who wish to teach in a public school, private school, or junior college.

Students ordinarily should have completed a minimum of 12 semester hours in their proposed major subjects and an additional 12 semester hours in related subjects. Should a student wish to undertake a graduate major different from the undergraduate major, the prerequisites may be modified upon the recommendation of the student's committee and the approval of the Dean of the Graduate School.

**Degree Programs.** Either of the following two programs may be arranged in consultation with the student's committee:

1. A student seeking certification must have a major of 18 to 24 units in education and 12 to 18 units in non-education courses, for a total of 36 units. A maximum of 6 of the 36 units required under this option may be 100-level or undergraduate education courses. A grade of *B* or better must be earned in any undergraduate course included in the 36-unit requirement.
2. A student who is already certified must have a major in non-education courses of 18 to 24 units and 6 to 12 units in education, for a total of 30 units.





The non-education courses are to be taken in one or more subjects usually taught in the secondary schools. The quantity and departmental distribution of this work will be determined by the needs of the individual student. A combined major in biological sciences or in physical sciences is possible in this program. Teachers who have already completed certification requirements must major in a teaching field in their Master of Arts in Teaching program. Students who have not completed certification requirements must major in education.

The Master of Arts in Teaching degree may be earned with or without the presentation of a thesis. If a student, in consultation with the thesis committee, elects to present a thesis, 6 units of the total of 30 or 36 units required may be granted for thesis research. The regulations governing the thesis are the same as those for the A.M. degree *with thesis*.

**The Committee.** Each candidate for the degree will be assigned a committee, appointed by the director of graduate studies in the major department or area. This committee will consist of three members, at least one of whom will be from the Department of Education, and at least one from another department. Usually the chairman of the committee will be chosen from the department of the major.

## MASTER OF HEALTH ADMINISTRATION

The Department of Health Administration offers a curriculum for graduate students interested in the field of health services management. It is designed primarily for students who hope to assume major leadership roles in a variety of organizations and programs that involve the provision of health services in public or private settings.

The Master of Health Administration program is designed around a core of courses in health services and management sciences, with electives in behavioral sciences. The student selects one of four concentrations for in-depth study: finance, personnel, planning, or information management. The academic program is five semesters in length. Upon completing the degree, the student usually undertakes a twelve-month rotating residency during which a salary is received. (Students with prior experience may petition for a waiver of the residency.)

Students with any undergraduate major may apply. One year of calculus at the college level is the only prerequisite, and a special course is available each summer for students whose preparation in mathematics is inadequate or out of date.

## The Doctoral Degrees

**Transfer of Credit.** Up to 30 units of graduate credit in which a grade of *G* (or its equivalent) or better was earned may be accepted by transfer only after the student has earned at least 12 units of graduate credit at Duke. Such transfer credit must be on the recommendation of the chairman of the student's advisory committee and the director of graduate studies of the student's major department. (Graduate School form T1 should be used to request transfer of credit.)

Credit for graduate courses taken at Duke by a student (not undergraduate) before admission to the Graduate School or while registered as a nondegree student may be carried over into a graduate degree program if: (1) the action is recommended by the student's director of graduate studies and approved by the Dean, (2) the work is not more than two years old, (3) the amount of such credit does not exceed 6 units, and (4) the work is of *G* level or better.

## DOCTOR OF PHILOSOPHY

The Ph.D. degree is a research degree. Although course work is a necessary part of the student's program, the mere accumulation of course credits will not be

sufficient for attaining this degree. The granting of the Ph.D. degree is based primarily upon the student's knowledge of a specialized field of study and upon the production of an acceptable dissertation embodying the results of original research.

**Requirements.** The formal requirements for the Ph.D. degree are as follows: (1) major and related courses, (2) foreign language(s) in most departments, (3) a supervisory committee for program of study, (4) residence, (5) preliminary examination, (6) dissertation, and (7) final examination. In order to be considered for candidacy for the Ph.D. degree, the student must have passing grades in all course work and a grade of C or better on at least 9 units of this course work.

**Foreign Languages.** The language requirements for the Doctor of Philosophy degree vary among departments. Some departments do not require a language; some require two languages; and others require a specific language. A prospective student should request information from the appropriate director of graduate studies if no such requirement is described under the departmental heading in this *Bulletin*. (For methods of meeting the requirement, see Language Requirements.)

Students working toward the doctoral degree should complete any language requirements set by their departments by the end of their first year of residence. Those who fail to meet the requirement by the end of their third semester of residence should register in the appropriate special reading course or courses. Any foreign language requirement must be met before the preliminary examination is taken.

**Major and Related Work.** The student's program of study demands substantial concentration on courses in the major department. However, a minimum of 6 units in a related field approved by the major department must be included. A few programs have been authorized by the Executive Committee of the Graduate Faculty to utilize courses in fields within the major department in fulfilling the related field requirement.

**Committee to Supervise the Program of Study.** As early in a student's course of study as is practicable and *not later than two months before the preliminary examination*, the director of graduate studies in the major department will nominate for the approval of the Dean a supervising committee consisting of five members, with one member designated as chairman. This committee will include at least three graduate faculty members of the major department and, usually, at least one from outside the department. For programs in which approval has been granted for related work from a clearly differentiated division within the department, one member of the committee will be chosen from that division. In this circumstance all members of the supervisory committee will be from the same department. This committee, with all members participating, will determine a program of study and administer the preliminary examination. Successful completion of the final examination requires four affirmative votes. The final examination may be administered by four members, if the representative of the related field is present.

**Residence.** The *minimum* registration requirement is 60 units of graduate credit, of which not more than 30 units may be accepted by transfer. Since a full program is 30 units per academic year, prospective Ph.D. candidates who enter with the A.B. or B.S. degree must plan to spend in residence a *minimum* of two academic years; if they enter with the A.M. degree, their *minimum* residence is one academic year. (For the definition of *residence*, see the chapter on Academic Regulations.) All students must register for a full program until they pass the preliminary examination. If there are undergraduate deficiencies in their programs, they may be required to take undergraduate courses for which they will not receive degree credit. Even if there are no such undergraduate deficiencies, the student's su-

pervisory committee will determine what requirements above the minimum, if any, the student must meet.

**Credit for Summer Work.** Credit earned in the summer session will not reduce the minimum required residence. (See the chapter on Study in the Summer.)

**Time Limitations.** Courses, language certifications, or other credits for advanced standing which are more than six calendar years old at the time that the preliminary examination is passed will not be accepted toward fulfilling the minimum requirements of the doctoral degree.

Ordinarily students should pass the preliminary examination by the end of the third year of graduate study. Those who have not passed the examination by the end of the third year of full-time registration must file with the Dean of the Graduate School a statement, approved by the director of graduate studies in the major department, explaining the delay and setting a date for the examination. Except under unusual circumstances, extension will not be granted beyond the middle of the fourth year.

The doctoral dissertation should be submitted and accepted within two calendar years after the preliminary examination is passed. Should the dissertation not be submitted and accepted within four years after the examination, the candidate, with the approval of the committee, may petition the Dean of the Graduate School for an extension of up to one year. If this extension is granted and the dissertation is not submitted and accepted by the new deadline, the student will be dropped from candidacy. The student must then pass a second preliminary examination to be reinstated as a candidate for the degree. In such cases, the time limit for submitting the dissertation will be determined by the Dean of the Graduate School and the candidate's committee.

In cases of particular merit, the Dean of the Graduate School may extend the limits of the total elapsed time within which credit will be allowed for courses, the language examination, and the preliminary examination. The graduate faculty of the departments will have these limits in mind when a student is considered for re-admission to the Ph.D program, for approval to take the preliminary examination, and for approval to submit the dissertation and take the final examination. In instances of excessive elapsed time, revalidation of credit may be required. Responsibility for requiring such revalidation rests with the department. Proposed requirements for revalidation require the approval of the Dean of the Graduate School.

**Preliminary Examination.** A student is not accepted as a candidate for the Ph.D. degree until the preliminary examination has been passed at Duke. The examination ordinarily covers both the major field and related work. In the summer a preliminary examination may be scheduled only between the opening and closing dates of the summer session.

**Privilege of Reexamination.** A student who fails the preliminary examination may apply, with the consent of the supervisory committee and the Dean of the Graduate School, for the privilege of a second examination to be taken no earlier than three months after the date of the first. Successful completion of the second examination requires the affirmative vote of all committee members. Failure on the second examination will render a student ineligible to continue a program for the Ph.D. degree at Duke University.

**Reduction in Registration.** A student who passes the preliminary examination during the first five weeks of each semester is eligible for a reduction in required registration and should arrange with the Graduate School Office the desired changes in registration.

**The Dissertation.** The dissertation is expected to be a mature and competent piece of writing, embodying the results of significant and original research.

One month before the dissertation is presented and no later than *February 1*



preceding the May commencement, *August 1* for a September degree, and *December 1* for a December degree, the student must file with the Dean of the Graduate School, on the official form available at the Graduate School Office, the title of the dissertation. This title must receive the written approval of both the director of graduate studies of the student's major department and the professor who directs the dissertation.

The basic requirements for preparing the dissertation (type of paper, form, and binding) are prescribed in the *Guide for the Preparation of Theses and Dissertations*, copies of which are available in the Graduate School Office.

The dissertation must be completed to the satisfaction of the professor who directs the dissertation, members of the student's advisory committee, and the Dean of the Graduate School. Four typewritten copies, bound in snap binders which may be secured through the Graduate School Office, must be deposited with the Dean of the Graduate School on or before *April 1* preceding the May commencement, one week before the end of the Duke summer session for a September degree, or one week before the end of the fall semester for a December degree. The dissertation must be submitted to the Graduate School Office at least seven days before the scheduled date of the student's examination.

All doctoral dissertations are published on microfilm through University Microfilms, Ann Arbor, Michigan. Authors may copyright them if they wish. Abstracts are published in *Dissertation Abstracts International*.

In brief, all copies of the dissertation, the original in clean type, will remain in snap binders until after the final examination. Three extra copies of the abstract (not more than 600 words long) are submitted when the dissertation is first presented to the Graduate School Office. A nonrefundable fee of \$30 is charged for microfilming. If copyright is desired, an additional fee of \$15 is charged. The original and two copies will be bound at a cost of \$5.50 per volume. The student may request that more than three copies be so bound. A deposit of \$3.50 is collected for each snap binder on loan from the library used for dissertation copies that will not be bound.

**Final Examination.** The final oral examination shall be primarily on the dissertation. However, questions may be asked in the candidate's major field. Except in unusual circumstances approved by the Dean, a final examination will be scheduled when school is in session.

A student who fails the final examination may be allowed to take it a second time, but no earlier than six months from the date of the first examination. Permission to take the second examination must be obtained from the professor who directed the dissertation and from the Dean of the Graduate School. Failure to pass the second examination renders the student ineligible to continue work for the Ph.D. degree at Duke University.

**Deposit of the Dissertation.** After passing the examination, candidates bring to the Graduate School Office the original and the first two copies of the dissertation, properly signed, as well as other copies they wish bound. At this time they sign the microfilming agreement and pay microfilming and copyright fees.

## DOCTOR OF EDUCATION

The Ed.D. degree is a professional degree for those who are, or intend to become, high-level professional personnel in the field of education. A student will choose one of the following as the area of concentration: (a) administration, (b) supervision, (c) counseling, (d) curriculum and instruction, (e) education of the emotionally disturbed, (f) higher education, (g) reading, or (h) school psychology.

To be considered as a candidate for the Ed.D. degree, the student must have





earned passing grades in the first 30 units of course work at Duke and a grade of C or better on 24 units of this course work.

**Major and Related Work.** The minimum registration requirement is 60 units of graduate credit, of which not more than 18 units may be in research or accepted by transfer. (Transfer credits which are more than six calendar years old at the time that the preliminary examination is passed will not be accepted.) A student's program must include at least 30 units of course work in the area of concentration and 12 units in related areas.

**Registration.** A student enrolled in the Ed.D. program must be registered for a minimum of 6 units of graduate credit in each academic year beginning with the first registration after admission to the Ed.D. degree program. For purposes of the Ed.D. program, an academic year begins September 1 and continues through the following August 31.

Once the preliminary examination is passed, two alternatives are open to a student as follows:

1. A student who remains in residence on campus during the fall and spring semesters must register for a minimum of 3 units of graduate credit for residence each semester. This registration entitles the student to all normal student benefits.

2. A student who goes out of residence (away from the University) must register for at least 6 units of graduate credit during each academic year (September 1 through August 31) until all requirements for the degree have been met. This entitles the student to routine faculty consultation and use of facilities. The out-of-residence "Ed.D. Leave" registration is restricted only to those students who have not passed the preliminary examination for the Ed.D. degree.

**Committee to Supervise the Program of Study.** As early in a student's course of study as is practicable, and not later than two months before the preliminary ex-

amination, the Director of Graduate Studies will nominate for the approval of the Dean a supervisory committee of five graduate faculty members, with one member designated as chairman. One or more members must represent the student's minor field. The committee will determine a program of study, administer the preliminary examination and, with such changes as are approved by the Dean, administer the final doctoral examination.

**Experience.** Prior to receiving the Ed.D. degree, the student must have at least two years of experience in professional education.

The program of study must include a minimum of 6 units in practicum, internship, and/or field experience under the direction of one or more faculty members.

**Time Limitations.** Students ordinarily should pass the preliminary examination by the end of their sixth year of graduate study at Duke. If they have not passed it by this time, they must file a statement endorsed by the Director of Graduate Studies with the Dean of the Graduate School explaining the delay and setting a date for the examination.

**Preliminary Examination.** A student is not accepted as a candidate for the Ed.D. degree until the preliminary examination has been passed. The examination covers both the major field and related work and is taken during or shortly after the term in which the approved course work is completed.



A student who fails the preliminary examination may apply, with the consent of the supervisory committee and the Dean of the Graduate School, for the privilege of a second examination to be taken no earlier than three months after the date of the first. Successful completion of the second examination requires the affirmative vote of all members of the committee. Failure on the second examination will render the student ineligible to continue a program in the Department of Education at Duke University.

**Dissertation.** The dissertation is expected to be a mature and competent piece of writing which demonstrates the student's ability to collect, arrange, analyze, evaluate, interpret, and report pertinent material in the area of concentration. This may embody the results of applied research in the form of a major project or model (for example; in-service education plans for a school system, computer programs, curriculum guides, instructional materials) or the results of significant and original research.

Procedural regulations governing the Ed.D. dissertation and final examination are identical to those for the Ph.D. degree.

### **Policy of Nondiscrimination**

Duke University does not discriminate on the basis of race, color, national or ethnic origin, or sex, in the administration of educational policies, admission policies, financial aid, employment, or any other University program or activity. It admits qualified students of any race, color, national or ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students.



# Special and Cooperative Programs







## Center for the Study of Aging and Human Development

The primary aims of the center are to encourage and support basic and applied research on biomedical, behavioral, and social scientific aspects of adult development and aging, to train research investigators for such research, and to develop sources of scientific information which are accessible to interested individuals and governmental agencies.

Although the center does not offer degrees, the varied programs and research laboratories provide a context and resource for undergraduate and graduate students with special interests in adult development and aging. The center does conduct multidisciplinary two-year programs for postdoctoral fellows interested in focused training for independent research on physiological, behavioral, and social scientific aspects of adult development and aging. Through a program of seminars, collaboration with the senior fellows of the center, and independent research, postdoctoral fellows are able to select and concentrate on selected issues of particular interest. Research methods, the development of specific research skills, and an interdisciplinary perspective are stressed. Resources of this all-University program include data from two longitudinal studies, a wide range of archival data of special interest to social scientists, and the center's basic and applied research laboratories. Undergraduate and graduate students of the University are welcome to inquire about participation in all programs at the center.

Access to the faculties of medicine and arts and sciences is facilitated by a tradition of multidisciplinary research and a central location on campus. Inquiries should be addressed to the Director, Duke University Center for the Study of Aging and Human Development, Box 3003, Durham, North Carolina, 27710.

## Canadian Studies Programs

The Canadian Studies Program was inaugurated in September, 1973, with the aid of grants from the William H. Donner Foundation and the Office of Education of the United States Department of Health, Education and Welfare for the purpose of formalizing and expanding the Duke Graduate School's interest in Canada, of introducing the study of Canadian life and culture at the undergraduate level, and

of encouraging such study in primary and secondary schools. The program's basic aim is to increase American knowledge and understanding of Canada.

The program awards graduate fellowships for the study of Canada by American residents in the Departments of History, Political Science, Sociology, Education, Health Administration, and Economics. Grants of travel aid for field research in Canada are also offered, and some teaching assistantships are given.

The program also sponsors lectures by Canadian specialists and cooperates with the Center for Commonwealth Studies in sponsoring the Commonwealth joint seminar on Canadian topics.

Publications arising from research on Canada may be published in the Commonwealth Studies Series.

Inquiries should be addressed to the Director of Canadian Studies, Center for International Studies, 2101 Campus Drive, Duke University, Durham, North Carolina 27706.

## **Center for Commonwealth and Comparative Studies**

The Center for Commonwealth and Comparative Studies was established at Duke University in 1955 and has received financial support from the Carnegie Corporation of New York, the Rockefeller Foundation, and the Ford Foundation.

The principal purpose of the center is to initiate, stimulate, and further academic interest in the Commonwealth in the broad sense of the internal and domestic affairs of the countries which are at present, or have been in the past, members of the Commonwealth in both contemporary and historical perspectives. In addition, it is concerned with the intra-Commonwealth relations of these countries, the organization of the Commonwealth, and in promoting comparative studies in which the Commonwealth or Commonwealth nations play a prominent role.

The center awards fellowships to graduate students from the Commonwealth countries who propose to study toward the Ph.D. degree in economics, history, political science, anthropology, or sociology at Duke University. National selection committees facilitate the selection of fellows.

Each spring the center sponsors a joint seminar for graduate students in economics, history, law, political science, anthropology, and sociology. The objective of this seminar is to encourage a broad approach to developments within the Commonwealth. The center also sponsors lectures at the University by distinguished Commonwealth scholars.

Studies resulting from research sponsored by the center are frequently published by the Duke University Press in the Commonwealth Studies Series, currently numbering forty-two volumes. Inquiries should be addressed to the Director, Center for Commonwealth and Comparative Studies, Duke University, Durham, North Carolina 27706.

## **Program in Comparative Studies on Southern Asia**

The Program in Comparative Studies on Southern Asia was established at Duke University in 1961, and has received fellowship and other support from the United States Office of Education for South Asia Studies since 1963 under the provisions of Title VI of the National Defense Act. The basic purpose of this program is twofold: to facilitate research on the political, historical, economic, and sociocultural development of Commonwealth countries in Southern Asia (India, Pakistan, Sri Lanka, Malaysia, and Singapore), and to provide for the systematic training of graduate students in anthropology, economics, education, history, political science, religion, and sociology, with special emphasis on the area.

Graduate students, in addition to meeting the requirements of the departments in which they are enrolled, are expected to take Hindi-Urdu or another major South Asian language, related courses in other departments, and to undertake field research in the preparation of their dissertations.

Predoctoral fellowships under the conditions specified above are made under the NDEA Title VI language fellowships offered by the United States Office of Education. Departmental and other University grants are open to applicants.

Facilitation and support of research activities by members of the Duke University faculty and graduate students are important aspects of the program's activities. Research grants for faculty and students are also available from the American Institute of Indian Studies. Research facilities include those materials received as a result of the University's participation in a library acquisitions program under the terms of Public Law 480.

The program has undertaken the publication of three series: hardcover monographs, reprints of articles of note dealing with the Southern Asian region, and a series of occasional papers. It also brings visiting Asian scholars to the campus for lectures and symposia, and co-sponsors forums and research activities with the Southern Atlantic States Association for Asian and African Studies and the Association of Asian Studies.

Inquiries should be addressed to the Administrative Assistant, Program in Comparative Studies on Southern Asia, Duke University, Durham, North Carolina 27706.

## Cooperative Program in Teacher Education

**Program in Secondary Education for the M.A.T. Degree.** Selected graduates of liberal arts colleges who have not completed a teacher preparation program will be admitted to the Cooperative Program in Teacher Education to complete their requirements for a teacher's certificate and to pursue additional training in the proposed teaching field. Full-year internships with salary are arranged with cooperating public and private school systems. Students admitted to this program are required to attend the Duke summer school before their year of teaching internship. This program is designed for students preparing to teach science, English, mathematics, or social studies in junior and senior high schools. For materials describing this program, write to the Graduate School, 127 Allen Building, or to the Director, Cooperative Program in Teacher Education, Department of Education, West Duke Building, Durham, North Carolina 27708.

## Cooperative Programs with Neighboring Universities

**Interchange of Registration.** (See Registration, the Reciprocal Agreements with Neighboring Universities.)

**Library Exchange.** Through a cooperative lending program, graduate students of the University of North Carolina and Duke University are granted loan privileges in both universities.

**Cooperative Program in Russian and East European History.** The graduate schools of Duke University and the University of North Carolina offer a cooperative program leading to the A.M. and Ph.D. degrees in several disciplines (economics, history, literature, linguistics, political science, and sociology), with a concentration in Russian and East European Studies. Students admitted to one institution are encouraged to enroll in courses advantageous to their programs at the other institution, and to utilize the libraries and facilities of both universities. The holdings of the two libraries in Russian and East European materials are substantial and



complementary. Both libraries have a policy of purchasing all significant published works in Slavic history, economics, government, geography, literature, and linguistics. Other joint activities include a monthly colloquium involving the personnel of the two institutions and distinguished visiting scholars.

A special project of the Duke program has been to assemble an outstanding collection of Soviet underground (*Samizdat*) literature (including letters and manuscripts) which is widely exhibited by the Committee.

A research program in Soviet economics (input-output analysis) provides special training for graduate students in this field and publishes a series of monographs under the auspices of a Ford Foundation grant.

## Center for Demographic Studies

A Population Studies Program was established at Duke University in 1963 to promote research and training in demography and human ecology. The program was renamed the Center for Demographic Studies in 1972 in recognition of its broad multidisciplinary focus and expanded research program. The facilities of the center include a population library, extensive data bank sources, and equipment for automated data processing. These are available to the entire Duke community.

Training under the auspices of the center leads to a Ph.D. degree within either the Department of Sociology or the Department of Economics. Although degrees are awarded through either department, the program is designed to provide an integrated cross-disciplinary training in the common specialty area of population studies. The bearing of sociological and economic theory upon the analysis of



demographic phenomena is emphasized, and participation in active research projects is afforded center trainees.

In addition to course and research opportunities which are open to interested graduate students in the University, a weekly non-credit seminar meets throughout the academic year for presentations by students, staff, and visiting guest lecturers.

Graduate fellowships for students in the training program are available. Inquiries may be directed to Dr. George C. Myers, Director, Center for Demographic Studies, Box 4732, Duke Station, Duke University, Durham, North Carolina 27706.

## Duke Environmental Center

The purposes of the Duke Environmental Center are to focus attention on pressing environmental problems, to provide orientation and educational opportunities in environmental subjects for both students and faculty, to promote interdisciplinary environmental research, and to serve as a point of contact for University and environmental agencies and the public. The center does not offer degrees, but allows students and faculty to emphasize the environmental aspects of their studies and research by becoming affiliated with the center while remaining in their established departments and professional schools. The center sponsors a visiting speaker program, graduate and faculty seminars, and graduate and undergraduate courses in environmental studies.

Information on environmental programs and courses offered at Duke and other institutions in the Research Triangle and on internships and opportunities in environmental careers may be obtained by writing or visiting the Environmental Center Office, 118 School of Engineering, Duke University, Durham, North Carolina 27706.

## The University Program in Genetics

The University Program in Genetics was established to provide for the coherent development of instruction and research in genetics throughout the University. The faculty of the program consists of scientists holding primary appointments in the various biological science departments. They have developed an interdepartmental graduate curriculum designed to meet the needs of students with a variety of educational backgrounds and professional objectives. Students in any of the science departments may specialize in genetics under the auspices of the interdisciplinary University Program in Genetics.

For current information consult Professor S.R. Gross, 151 Nanaline H. Duke Building, Duke University, Durham, North Carolina 27710.

## Hispanic Studies Program

The Graduate School offers an interdepartmental program in Hispanic studies leading to the A.M. and Ph.D. degrees. Students may write their theses and take their degrees in history, economics, political science, sociology, or Hispanic languages and literature. The purpose of the program is to provide a desirable combination of courses on the Hispanic world in these disciplines and to give candidates more rigorous training in Hispanic studies. In consultation with the candidate, a faculty committee will determine a special program of study.

The holdings of the Duke University library for graduate work and research in Hispanic American history, inter-American relations, economic history, politics, art, and Spanish American literature are constantly being enlarged.

## Medical Scientist Training Program

The Medical Scientist Training Program, conducted under the auspices of the Graduate School and the School of Medicine, is designed for students with a strong background in science who are motivated toward a career in the medical sciences and academic medicine. It provides an opportunity to integrate graduate education in one of the sciences basic to medicine with the clinical curriculum of the School of Medicine. The program requires six to seven years of study and leads to both the M.D. and Ph.D. degrees. Although the special emphasis of this program is on basic medical science, the trainees, because of their education in clinical medicine, have a remarkable range of career opportunities open to them. Graduates of this program generally follow one of two broad paths. Some directly pursue careers in teaching and research in one of the basic medical sciences, while maintaining strong ties with clinical science as a result of their combined training; others enter residency programs before pursuing investigative and teaching careers in clinical medicine, carrying with them strong academic backgrounds in the basic sciences.

**Eligibility.** Applicants must meet the admission requirements of both the Graduate School as a candidate for the Ph.D. degree and the Medical School as a candidate for the M.D. degree. Most candidates apply for admission to the first year of the program, but applications are accepted from students who are currently in residence in the Graduate School or Medical School of Duke University. In addition to the minimum requirements for acceptance in the Graduate School and the Medical School, advanced course work in science and mathematics as well as prior research experience count heavily in the selection of candidates.

**Financial Support.** Students admitted to the first year of the program in 1977 will receive a traineeship award, consisting of a stipend and full tuition allowance, provided by a grant from the National Institutes of Health. The annual stipend is \$3,900. Current policy of the National Institutes of Health limits the duration of the traineeship to six years; support will be continued for that period (or until the completion of both degrees, if earlier), provided that progress remains satisfactory. This traineeship, created by the National Research Service Award Act of 1974 (PL 93-348) provides (as do all research training awards under this act) for certain alternate service or payback requirements in the event that a research career is not pursued.

**The Training Program.** This program has been designed to offer trainees latitude in the selection of course material. Basic requirements are two academic years composed of the first basic science year and the second clinical science year of the curriculum for medical students at Duke University. Following completion of the second year, the trainee enters the graduate program to complete the requirements for the Ph.D. degree. A final academic year of elective clinical study is necessary to complete the requirements for the M.D. degree. Both degrees are awarded at the completion of this sequence.

Additional information may be obtained by writing Professor Henry Kamin, Associate Director, Medical Scientist Training Program, Department of Biochemistry, Duke University Medical Center, Durham, North Carolina 27710.

## The Medical Historian Training Program

The Medical Historian Training Program is conducted under the auspices of the School of Medicine and the Graduate School to provide professionally trained medical historians. A minimum of six years of graduate study is required. Upon satisfactory completion of the program, the M.D. and Ph.D. degrees will be awarded. It is anticipated that graduates will undertake a minimum of one year of

postgraduate medical training, following which their major effort will be in teaching and scholarly activities in the field of the history of medicine. They also may have minor clinical responsibilities.

Basic requirements are two academic years in the School of Medicine consisting of "core" basic sciences in the first year, ending with the course, Introduction to Clinical Medicine, and "core" clinical sciences during the second year, following which the student enters the Department of History in the Graduate School.

Candidates for the Ph.D. degree in history devote approximately two full years to the completion of their required courses, work in seminars, and preparatory study for the preliminary or qualifying examination. The actual length of time needed to earn the Ph.D. degree depends upon the number of years beyond the two years which candidates find necessary for researching and writing dissertations. Candidates will pursue studies in the Department of History during the third and fourth academic years of the program. In the fifth and sixth years, the student should have one year in which to pursue medical-historical research and one year of elective courses in the School of Medicine to fulfill the requirements for the M.D. degree. This elective year in clinical science is entered only after completion of all requirements for the Ph.D. degree.

**Application and Admission Procedures.** Applicants must meet the requirements for admission to the School of Medicine and the Graduate School in the Department of History. Candidates who have completed two years of medical school will also be considered.

In addition to the minimum requirements established by the School of Medicine and the Graduate School, courses already taken in history and the history and philosophy of science will count heavily in the selection of candidates.

Applicants should complete and submit an application to the Graduate School for admission to the Department of History.

Additional information may be obtained by writing to Seymour Mauskopf, Ph.D., Director, Medical Historian Training Program, 206 East Duke Building, Durham, North Carolina 27708.

## **Institute of Policy Sciences and Public Affairs**

The graduate program in public policy sciences is offered through the Institute of Policy Sciences and Public Affairs. The course of study consists of a series of joint degree programs leading to the Master of Arts degree and a doctoral or professional degree. This program helps students to acquire the knowledge, concepts, and analytical skills necessary for sound public decision-making. The Institute awards independent A.M. or Ph.D. degrees only to those already possessing doctoral or professional degrees. All other graduate students in the Institute must pursue a concurrent degree in another department or school at Duke or at a nearby cooperating institution. Formal joint degree programs exist or are being developed between the Institute and the Schools of Law, Engineering, Medicine, and Business Administration, with several graduate departments, and with schools and departments at the University of North Carolina at Chapel Hill.

Students may apply for the joint degree program simultaneously with their applications to other graduate departments or professional schools, or during their first or second year of advanced study. Candidates are expected to complete an equivalent of one full year of work beyond that required by their doctoral or professional degrees.

The joint degree curriculum involves a minimum of ten courses to be specified by the Institute. Academic work includes a research sequence and a summer in-

ternship in a number of specialized policy areas including law and the administration of justice, urban development, communications, health, national defense, and education. This policy research sequence, in which the student works closely with faculty in a tutorial or a small group, stresses the development of analytical skills applicable to the broad range of policy areas.

Further information may be obtained from the Director of Graduate Studies, Institute of Policy Sciences and Public Affairs, 109 Old Chemistry, Duke University, Durham, North Carolina 27706.

## Oak Ridge Institute of Nuclear Studies

Duke University is one of the sponsoring universities of the Oak Ridge Associated Universities located at Oak Ridge, Tennessee. The graduate research program at Duke has available to it all the facilities of the Oak Ridge National Laboratory and the cooperative supervision of student research by the staff at Oak Ridge. Fellowships in several fields of science are available to qualified applicants.

**Graduate Fellowship Program.** On application by a university, ORAU awards fellowships to candidates for the master's and doctor's degrees. The student uses the fellowship to conduct thesis research in an Oak Ridge laboratory.

The application deadlines depend upon the fellowship. Further information may be obtained from Boyd R. Strain, Department of Botany, Duke University, Durham, North Carolina 27706.

## Organization for Tropical Studies

Duke University is a member of a consortium created to promote an understanding of tropical environments and how to use them intelligently. To achieve these objectives, the Organization for Tropical Studies (OTS) fosters research and educational programs in the New World tropics.

Fellowships are available for travel and subsistence in field-oriented programs in Central America. The basic course, Tropical Biology: An Ecological Approach, runs for an eight-week period in January-February and in July-August. Advanced offerings are periodically scheduled in agriculture, anthropology, botany, earth sciences, forestry, geography, marine biology, meteorology, and zoology.

The course schedules and application deadlines vary from year to year. Consult Dr. Donald Stone (Botany), Dr. Peter Klopfer (Zoology), or their respective departments for information.

## Program in Medieval and Renaissance Studies

The graduate Program in Medieval and Renaissance Studies is administered by the Duke University Committee on Medieval and Renaissance Studies. A participating student is based in one of the regular departments and fulfills the Ph.D. degree requirements for that discipline. In addition, students take a program of electives which will advance their interdisciplinary competence in the medieval or Renaissance areas. Such a program may include a choice from the fields of art history, language and literature, history, philosophy, and religion. Participation in the Program in Medieval and Renaissance Studies will fulfill the requirement for work in a related field.

The Committee on Medieval and Renaissance Studies awards annual fellowships to outstanding doctoral students. Each fellowship is renewable twice, with renewal based on a review of the student's program by the committee.

The Committee on Medieval and Renaissance Studies also sponsors an undergraduate program; the *Journal of Medieval and Renaissance Studies*, a monograph series in the field; and lectures by distinguished visiting scholars.



Inquiries should be addressed to the Chairman, Duke University Committee on Medieval and Renaissance Studies, Box 4666, Duke Station, Durham, North Carolina 27706.

## Social Systems Simulation Program

This is an interdisciplinary program to stimulate the use of model building and computer techniques in the social sciences. An outgrowth of the Econometrics Program, the program is broadly based involving the participation of faculty from business administration, economics, education, mathematics, political science, psychiatry, psychology, and sociology. It provides resources and facilities for predoctoral students pursuing the Ph.D. degree in a variety of fields. Inquiries should be addressed to the Director, Social Systems Simulation Program, Economics Department, Durham, North Carolina 27706.

## Center for Southern Studies

The Center for Southern Studies engages in interdisciplinary inquiries into both the contemporary and historical South. It is concerned both with scholarly research and its practical application in the emerging industrial states of the region and has been instrumental in the creation of a multi-state Southern Growth Policies Board to foster regional economic planning. Under the auspices of the board, Southern business, labor, educational and political leaders, including nine governors, are engaged in developing modern approaches to basic problems.

The center's Oral History Project focuses upon developing additional Black sources on the Southern past in hopes of fostering a multiracial history of the region. The center is also cooperating with the Department of History in training graduate students in the methods of oral research.

The center offers an interdisciplinary undergraduate course entitled *The Changing South* (IDC 199) which explores the geography, economics, politics, and culture of the region. The staffs of the center and the Perkins Library have created a Center for Southern Studies Reading Room containing over 300 volumes relating to the historical and contemporary South.

Inquiries relating to the Oral History Program should be addressed to Dr. Lawrence Goodwyn or Dr. William Chafe, 219 Old Chemistry Building, Duke University, Durham, North Carolina 27706.

## Predoctoral Training Program in Sciences Related to the Nervous System

This training program is designed to train scientists to have a broad understanding of the current status, techniques, and approaches of the disciplines contributing to our knowledge of the nervous system, behavior, and mental health. Participants work toward the Ph.D. degree in one of the following participating departments: anatomy, microbiology and immunology, physiology and pharmacology, biochemistry and genetics, pathology, or psychology. In lieu of the minor field of study, they have an expanded curriculum, tutorial courses, and seminar series in the current issues of neurobiology. Each curriculum is structured by a committee to satisfy individual needs and interests. This program is especially designed to develop individuals who have a broad understanding of the neurosciences and are equipped to contribute to the expansion of knowledge through research in their fields. Further information may be obtained by writing Frans F. Jöbsis, Ph.D., Chairman, Training Committee, P.O. Box 3709, Duke University Medical Center, Durham, North Carolina 27710.

# Resources for Study





## The Libraries

**The William R. Perkins Library and Departmental Libraries.** The William R. Perkins Library has shelf space for 2,500,000 books, seats for 2,100 readers, and a staff of 200. Study space includes nearly 700 carrels (200 closed and 500 open) of which 475 are in the new building.

On the main floor—at ground level—are the reference and loan departments, bibliographies, current periodicals, interlibrary loan, and all units of technical processing. Documents, newspapers, and a microtext collection, as well as a microphotography laboratory and other copying facilities, are located on the floor below. The administrative offices and graduate reading room are on the second floor, with manuscripts and archives on the third. Twelve small reading and study rooms are provided in the stacks for the departments in the humanities and social sciences which grant the doctorate. Four seminar rooms are also located in the stacks.

Microphotography and photographic services utilize modern equipment for reproducing printed and manuscript materials and for the reading of materials in the microtext collection. A special room is available to film readers.

The combined University libraries, including Perkins Library and nine school and departmental libraries, contained 2,764,348 volumes in the summer of 1976. The Perkins Library had 1,702,816 volumes; the Undergraduate Library, 18,839 volumes; Divinity School, 184,302 volumes; Engineering, 56,141 volumes; Law, 201,105 volumes; Medical Center, 149,624 volumes; East Campus Library, 184,921 volumes; Biology-Forestry, 123,178 volumes; Chemistry, 34,567 volumes; Mathematics-Physics, 52,856 volumes; and Music, 45,523 volumes. Over 144,000 volumes were added in 1975-1976. Approximately 13,000 periodicals and over 200 newspapers are received currently.

The extensive resources of the library for students doing research may be suggested by the following special collections:

The Trent Collection of Walt Whitman, containing the first, as well as all other important early editions or issues of *Leaves of Grass*; books and articles of Whitman biography and criticism; nearly 300 manuscripts, 400 letters, pictures, sheet music, and other miscellany.

The George Washington Flowers Collection of books, manuscripts, pamphlets, and newspapers on all phases of Southern history.



The Arents Collection of several hundred volumes relating to the culture and production of tobacco and the manufacture and distribution of tobacco products.

The James A. Thomas Collection of books on Chinese history and culture.

The Guido Mazzoni Library, a collection of approximately 23,000 volumes and 67,000 pamphlets covering Italian literature, with special strength in the nineteenth century.

The Gustave Lanson Library of 12,000 books and monographs on French literature.

The Latin-American Collections, built around a Peruvian library of 7,000 books and manuscripts, a Brazilian library of several thousand volumes, and an Ecuadorian library of 2,000 volumes, supplemented by strong collections of the public documents of these and other Latin-American countries.

The Robertson Library of Philippiniana.

The Frank C. Brown Folklore Collection, consisting of about 38,000 manuscript pieces, 1,400 vocal recordings, and 650 musical scores of North Carolina folklore.

The Strisower Library of international law, numbering nearly 5,000 volumes, with rare books and periodical files.

The Trent Collection in the History of Medicine (Medical Center Library), containing about 3,000 books and 2,500 manuscripts, with special strength in anesthesia, anatomy, English medicine, vaccination, yellow fever, pharmacy, and medical biography.

The Holl Church History Library, dealing primarily with the period of the Reformation.

The Frank Baker Collection of Wesleyana and British Methodism, consisting of 1,500 editions of the works of John and Charles Wesley, 8,000 volumes concerning all phases of the development of British Methodism, 4,000 volumes relating to the religious and social background of British Methodism, and 4,000 manuscript pieces by the Wesleys and their coadjutors and by British Methodists of the last 200 years.

Collections in English and American literature, with emphasis on the eighteenth and nineteenth centuries, including collections of Swinburne, Tennyson, Rossetti, and Bryant, significant groups of annotated copies and first editions of Coleridge and Byron, the Carroll Wilson collection of Emerson, some 5,000 items of eighteenth century English poetry and prose, and the Paul Hamilton Hayne Library of American literature.

In addition to these and other special collections, the library contains excellent files of United States federal and state documents, public documents of many European and Latin American countries, and publications of European academies and learned societies. The newspaper collection, with 15,000 volumes and 63,000 reels of microfilm, has several long eighteenth century files; strong holdings of nineteenth century New England papers and of antebellum and Civil War papers from North Carolina, South Carolina, and Virginia; and many European and Latin American papers. The manuscript collection of over 4,500,000 items is particularly strong in all phases of the history, politics, and social and economic life of the South Atlantic region and includes significant papers in English and American literature. The collection of 138 Latin and 65 Greek manuscripts constitutes one of the outstanding collections of its kind in the United States.

**The Medical Center Library.** Located in the Seeley G. Mudd Communications Center and Library Building, the Medical Center Library provides the services and collections necessary to further educational, research, and clinical activities in the medical field. Its services are available to the students, faculty, and staff of the



Schools of Medicine and Nursing; of the Division of Allied Health; of Duke Hospital; and of the graduate departments in the basic medical sciences. Other students and faculty needing access to biomedical literature may apply for privileges upon application to the Chief of Readers' Services.

Over 160,000 volumes are available, including the Trent Collection in the History of Medicine. Approximately 2,200 journal titles are received, in addition to extensive back files of older materials. The library has several types of audiovisual materials and equipment. With the exception of certain items shelved on reserve, these materials have been integrated into the general book and journal collections and are listed in the card or journal catalogues.

The Frank Engel Memorial Collection consists of a small group of books on non-medical subjects for general reading, together with several newspapers and popular magazines. Traditional reference services are supplemented by on-line bibliographic systems and computer-produced specialized indexes.

The uniform borrowing privileges apply to all registered users. Details of loan and other services may be found in the guide which is published each year and is available at the library.



**The School of Law Library.** The School of Law Library, with approximately 200,000 volumes, serves both the University and the local legal community. The collection contains nearly all reported decisions of the federal, state, and territorial courts of the United States, British Commonwealth, and representative foreign jurisdictions. It also includes the constitutions, codes, statutes, and subsidiary legislative publications of all these jurisdictions as well as many digests, indexes, bibliographies, and related research tools. A large section of the library collection is devoted to treatises on all phases of law and legal sciences, as well as to materials in the fields of history, economics, government, and other social and behavioral sciences relevant to legal research. There are files of selected federal documents, and since 1970 a complete set of congressional materials has been maintained. The Christie Jurisprudence Collection is located in the main reading room. Other collections include legal history, administrative materials, intellectual property, criminal procedure, school law, and briefs of the U.S. Supreme Court, the Fourth Circuit Court of Appeals, the North Carolina Supreme Court, and the North Carolina Court of Appeals. Undergraduate and graduate students whose course of study requires access to legal literature are welcome to use the collections.

## Science Laboratories

**Botanical and Zoological Laboratories.** Facilities for graduate study in the Departments of Botany and Zoology are located on the West Campus. The Biological Sciences Building contains well-equipped modern laboratories for teaching and research in the fields of botany, forestry, and zoology. Special facilities include animal rooms, greenhouses, darkrooms, refrigerated and controlled-environment laboratories, scanning and transmission electron microscopes, a Van de Graaf accelerator, X-ray machines, radiation and radioisotope equipment, and other modern research facilities. Extensive facilities for experimentation in environmental control of plant growth are available in the phytotron adjacent to the botany greenhouses.

The herbarium contains over 360,000 specimens and includes notable collections of mosses and lichens. Other assets for teaching and research are the Sarah P. Duke Gardens on the West Campus; the four-acre experimental plot and field laboratory developed by the Department of Botany; the Duke Forest, comprising 8,000 acres of woodland adjacent to the West Campus; the field station for the study of animal behavior; and the Duke University Marine Laboratory at Beaufort, North Carolina. Duke University, through the Botany and Zoology Departments, is a



member institution of the Organization for Tropical Studies in Costa Rica, a facility which provides opportunities for course work and research in tropical flora and fauna.

Scholarships for advanced study during the summer months are available through the Highlands Biological Laboratory, Highlands, North Carolina. Requests for information concerning scholarships at the Highlands laboratory should be addressed to the Botany Department.

**The Phytotron.** The phytotron, officially known as the Duke University unit of the Southeastern Plant Environment Laboratories, is adjacent to the Biological Sciences Building and is administered by the Botany Department. The phytotron is an integrated series of plant-growth rooms, chambers, and greenhouses, with forty-six separately controlled environments providing more than 4,000 square feet of plant-growing space. The factors of the environment controlled in the units to study plant growth include light, temperature, nutrients, CO<sup>2</sup> concentration, and humidity. By using the conditions in various day and night combinations, an exceptionally large number of environments can be simulated for testing the growth responses of plants. The phytotron also includes research laboratories and facilities for strying and monitoring the physiological processes of plants.

Research space in the phytotron is available to graduate students and faculty at Duke and to members of other educational and research organizations. For information concerning awards and research space, contact Dr. Henry Hellmers, Director of the Phytotron, Department of Botany, Duke University, Durham, North Carolina 27706.

**Marine Laboratory.** The Duke University Marine Laboratory (DURL) is located at Beaufort, North Carolina, on Pivers Island, with direct access to the open ocean, numerous bars and shoals, maritime marshlands, and various tributaries. The laboratory employs over one hundred persons and accommodates nearly 2,000 students per year, including fifteen to twenty graduate students in residence year-round. Offerings include a full undergraduate spring term, two international training programs, a cooperative undergraduate teaching program with thirteen participating universities, and three terms of summer school courses for graduates and undergraduates. These courses fulfill graduate credits in the Departments of Zoology, Botany, Geology, Chemistry, Biochemistry, Physiology and Pharmacology, and Biomedical Engineering. The physical plant consists of twenty-three buildings, including six air-conditioned laboratories, one classroom building, five dormitories, a maintenance complex, and a dining hall. The Laboratory has several small skiffs; three intermediate-size vessels; a fifty-eight foot trawler, the R/V *Beveridge*; a new sixty-two foot research-workboat, the R/V *John deWolf II*; and a 118-foot oceanographic research vessel, the R/V *Eastward*.

For information concerning teaching and research space, write to the Business Office, Duke University Marine Laboratory, Beaufort, North Carolina 28516. For information concerning courses, refer to the *Marine Laboratory Bulletin* or to Marine Sciences—the University Program in the chapter on Courses of Instruction.

**Animal Behavior Station.** The Animal Behavior Station, located less than one mile from campus, provides facilities for the study of penned, free-ranging, and caged animals in a wooded area of eighty acres. These facilities include sound-proofed observation chambers, barns, aviaries, pens for large animals and birds, and two waterfowl ponds. An extensive facility for the study of prosimian primates was completed in 1968. It contains one of the world's largest collections of lemurs in rooms especially designed for observational and behavioral studies. For information regarding research space or research assistantships in animal behavior, write to Dr. P. H. Klopfer, Department of Zoology, Duke University, Durham, North Carolina 27706.





**Primate Facility.** The Duke University Primate Facility is located in the Duke Forest adjacent to the Animal Behavior Station, about two miles from the main campus. The colony is composed of approximately 200 prosimian primates representing twelve species. The animals are utilized by faculty members and students in the Departments of Anatomy, Anthropology, Psychology, and Zoology for research in cytogenetics, comparative anatomy, animal behavior, and physiology. Information concerning graduate study in one of these areas should be directed to the director of graduate studies of the appropriate department. For information pertaining to the use of the Primate Facility and availability of research space, write to Dr. J.A. Bergeron, Managing Director, Duke University Primate Facility, 3705 Erwin Road, Durham, North Carolina 27705.

**Physics Laboratories.** The Physics Building, containing about 103,000 square feet of floor space, is devoted to research and instruction in the Departments of Physics and Mathematics. An additional 27,000 square feet of space is provided in the adjacent Nuclear Physics Building completed in 1968. Graduate students usually have office space in one of these two buildings.

In addition to the lecture halls and the elementary laboratories, there are instructional laboratories for work in electronics and advanced physics.

Nearly half the building is devoted to special laboratories for research in microwave spectroscopy and atomic, nuclear, high energy, low temperature, and solid state physics. Special equipment includes microwave spectrographs operating up to 500,000 megacycles; one 4 MeV and one high-resolution 3 MeV Van de Graaf accelerator, a 30 MeV cyclotron/tandem Van de Graaf accelerator, a helium liquefier, cryostats, magnets, and associated equipment for research down to the millidegree Kelvin temperature range; a Sigma-5 and a DDP-24 computer used for automatic





measurement and processing of bubble chamber film in the High Energy Physics Laboratory; and two DDP-224 computers used to collect and process data in the nuclear structure laboratory.

The Physics-Mathematics Library contains a large selection of books and periodicals. A spacious, well-equipped instrument shop located in the building is staffed by ten instrument makers, ten electronics technicians, and a glassblower.

**Chemistry Laboratories.** The Department of Chemistry is housed in the Paul M. Gross Chemical Laboratory, a building containing 146,440 square feet of total area. The well-equipped Chemical Laboratory provides conditions conducive to research in many areas of current interest. Nuclear magnetic resonance facilities include 60 MHz, 100 MHz, and Bruker 90 MHz spectrometers. The latter instrument is equipped with a complete range of decoupling accessories, as well as Fourier transform capabilities for  $^{19}\text{F}$ ,  $^{15}\text{N}$ ,  $^{13}\text{C}$ ,  $^{31}\text{P}$ , and  $^1\text{H}$  nuclei. Two ESR spectrometers, including a Varian E-9, provide excellent facilities for research in electron spin resonance. Mass spectrometric service is provided by a CEC 21-490 mass spectrometer as well as access to an A.E.I., Ltd., MS-902 located in the Research Triangle Park. X-ray diffraction cameras of all types are available, along with Enraf-Nonius automatic and Picker automatic full-circle diffractometers. Numerous instruments of varying sophistication for fluorescence, infrared, u.v., and ORD-CD spectroscopy are available. Several preparative and analytical gas and liquid chromatographs are also located in the building. Computing facilities include PDP-81L and PDP-81F laboratory computers and an IBM 370/165, the latter located in the Research Triangle Park and linked by microwave to the Duke University Computation Center. The department has a machine shop, an electronics shop, and a glassblowing shop. The facilities of the Duke University Marine Laboratory on the coast

at Beaufort, North Carolina, are available for specimen collecting and processing studies of organic chemicals of marine origin. The Department of Chemistry Library is also located in the Paul M. Gross Chemical Laboratory, with holdings of approximately 30,000 volumes. The library receives 330 current scientific periodicals.

**The Nanaline H. Duke Building.** The Nanaline H. Duke Medical Sciences Building offers a superb environment for the creative research and education of faculty and graduate students in the Departments of Biochemistry, and Physiology and Pharmacology. The building provides more than 65,000 square feet of laboratory space arranged in four towers around a central service core. Individual laboratories are designed to meet the special needs of research programs dealing with living organisms. Controlled-environment rooms, darkrooms, materials-purchasing facility, electronics shops, a library, and conference and reading rooms are provided. A vivarium for the temporary care and treatment of experimental animals is also located in the building.

**Psychology Laboratories.** The Psychology Department occupies approximately 53,000 square feet of air-conditioned space on the main campus, in a building which houses general purpose laboratories, seminar rooms, classrooms, and a number of special facilities. For the study of animal behavior there are videotape-recording facilities, a breeding colony of ring doves and pigeons, an extensive collection of prosimians, and operant-conditioning laboratories. There are sound-proofed and electrically shielded rooms for use with human and animal subjects, rooms for computer-controlled experiments in human perception and memory, photographic darkrooms, electrophysiological recording rooms, and a histological laboratory and surgery. The social psychology unit (used jointly with the Department of Sociology) contains observation, communication, and videotape-recording facilities for the study of social interaction. There are interview and observation rooms for the study of human personality and clinical processes and a fully equipped experimental trailer for studying the behavior of children on location. Both laboratory computers and remote access to the IBM and Hewlett-Packard computers located at the Triangle Universities Computation Center are available in the building. Machine, wood, and electronics shops are staffed by three full-time technicians. Other facilities for research and teaching are available in the laboratories and clinics of the adjacent Duke Medical Center.

A number of clinical installations for adults and children, specializing in clinical and guidance problems, cooperate with the department in providing facilities for research and training. The department runs an experimental school for first- and second-grade and preschool children, and cooperates with the Department of Zoology in operating an eighty-acre field station and primate facility in nearby Duke Forest for the study of animal behavior in natural settings (see Animal Behavior Station).

**Computation Center.** The Duke University Computation Center, available to faculty and students for research and instruction, is presently equipped with an IBM 370 135 computer (393 thousand bytes of memory, one 3330 disk facility, three tape drives, two card readers, three printers, and a digital X-Y plotter) which is connected by a high-speed microwave link to an IBM 370/165 computer (four million bytes of memory, two 3330 and one 2314 disk facility, seven tape drives, card reader, and printer) located at the Triangle Universities Computation Center (TUCC) in the Research Triangle Park. There are several low-speed keyboard terminals in addition to three medium-speed terminals (card reader and printer) located in the Engineering Building, the Sociology-Psychology Building, and the Biological Sciences Building.

The Triangle Universities Computation Center is a nonprofit corporation

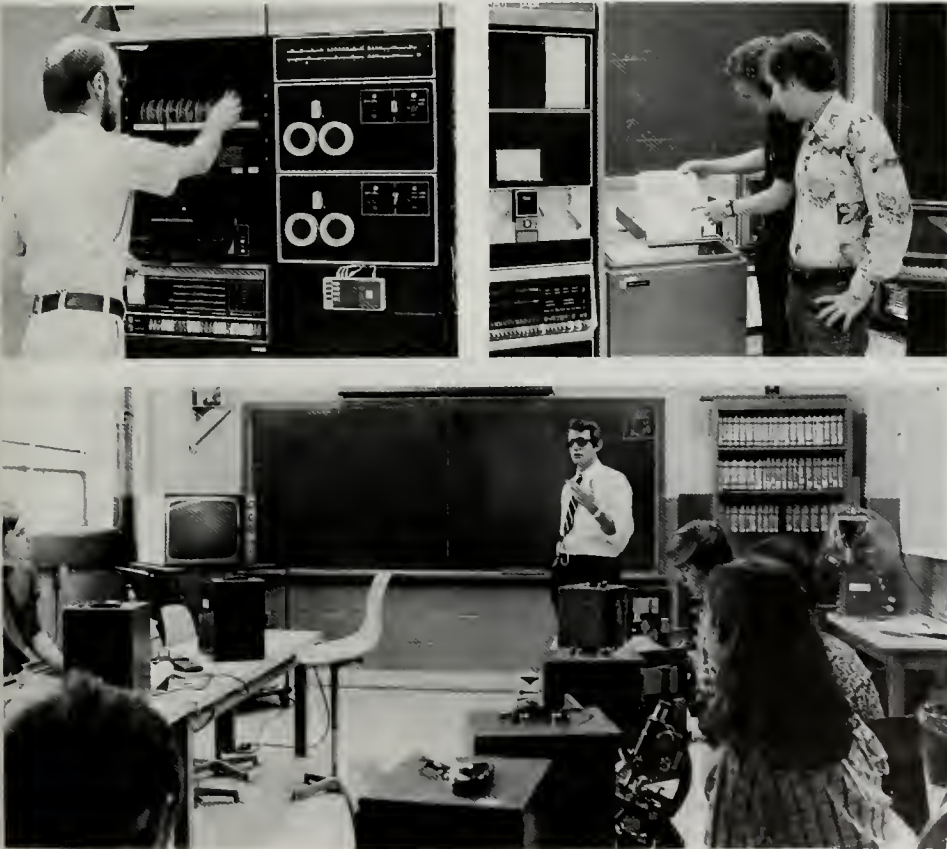
formed jointly by Duke University, North Carolina State University at Raleigh, and the University of North Carolina at Chapel Hill.

Faculty members at Duke may use these facilities by filling out an application for computer services. All users of the Computation Center facilities are urged to obtain funds to pay for computer services; however, those unable to obtain grant funding may ask for financial support from their departments when they apply for the services.

More specific information regarding Duke computing facilities may be obtained from the Director of the Computation Center.

**Engineering Research Laboratories.** The laboratories of the four departments of the School of Engineering contain extensive basic equipment that may be applied in several specialized fields. Each laboratory also contains selected sophisticated equipment used in advanced research. The facilities available for instruction and research are suggested by the following brief listing of equipment found in each department:

*Biomedical Engineering.* Holography and ultrasound apparatus; high energy CW helium-neon gas laser, and interferometrically stable table; cellular electrophysiology and neurophysiology instrumentation; stereomicroscope, micromanipulators, stimulators, isolation units, and microelectrode puller; facilities for studying biomedical materials and surface interactions; polarizing microscope, internal reflectance infrared spectrophotometer, and dialyzers; soft tissue creep and relaxation test system; biocellular material testing equipment; cardiorespiratory measurements; respirator; a DEC PDP-12 and several PDP-11 digital computers.





*Civil Engineering.* Well-equipped research laboratories are available for work in environmental engineering, soil mechanics and geotechnical engineering, solid mechanics and materials engineering, structural mechanics and structural engineering, fluid mechanics, water resources and ocean engineering, and urban systems and transportation engineering. Available research facilities include two independent closed-loop electrohydraulic dynamic loading systems (MTS) capable of applying pulses of any shape and controlled in force or displacement modes, frequency range up to 100 cps., load capacity 6,000 and 100,000 lbs. (the 6,000 lbs. actuator can develop a constant crosshead speed up to 50,000 in./min.); equipment for manufacture and testing of fiber-reinforced polymer composites; environmental chamber for testing in the temperature range of  $-320^{\circ}$  to  $500^{\circ}$  F., ultra-high-pressure triaxial shear apparatus for confining pressures up to 100,000 psi; high-speed camera for studying explosions and similar phenomena; particle tracking X-ray equipment for soil deformation studies; rock-testing facilities; model-testing equipment for anchored walls, penetrometer studies, and deep pile foundations; a large-aperture research polariscope; a reflective photoelastic polariscope; sustained-loading facility for long duration in studies of prestressed concrete; and a PDP-8 digital computer with an 8K core memory size, teletype console, paper tape and magnetic tape I/O capabilities, and teletype terminals which are also connected to the IBM 370/165 computer at the Triangle Universities Computation Center.

*Electrical Engineering.* Digital data processing laboratory equipped with DEC PDP-8 I and PDP-11/45 computers including graphic displays, X-Y tablets, and remote input-output terminals; microwave facilities for experimentation up to 35 GHz; X-ray diffractometer with monochromator and low temperature attachments; cryomagnetic Faraday balance for magnetic susceptibility measurements; EPR spectrometer; 4 inch and 9.5 inch electromagnets; and 2 inch-bore superconducting magnet.

*Mechanical Engineering and Materials Science.* Digital data acquisition system with high speed scanner and magnetic tape; FM-AM instrumentation recorder; 4 square foot subsonic wind tunnel with six-component balance; hot-wire anemometer system; storage and dual-beam oscilloscopes; X-Y and strip chart recorders; temperature, pressure, strain, force, and acceleration transducers; electrodynamic shaker table; sound room; spectrum analyzers; MiniAC and TR-20 analog computer facilities; D17B Minuteman digital minicomputer; CRT Data I/O terminal with







hardcopy unit; fuel research engine; materials laboratories with stereo zoom research metallograph, polarizing and low-temperature microscopes, electron microscope, thermal analyzer, Instron testing machine, high vacuum system, instrumented plastics extruder and injection molder, 10 kw RF generator, heat treating and arc-melting furnaces, recorders, constant load stress corrosion tester, and dark-room facilities.

The School of Engineering is associated with the F.G. Hall Laboratory for Environmental Research at the Duke University Medical Center where opportunities are provided for research in environments from pressures of 1 Torr (155,000 feet of altitude) to 466 psig (1000 feet of depth in seawater) with a variety of gases, temperatures, and humidities. All basic equipment for measuring and recording physiological and physical phenomena are provided. Experiments may be performed in vitro or in vivo with animals or human subjects. Areas of interest have been heat and mass transfer, fluid flow, and thermal regulation.

The shop facilities of the School, as well as those located elsewhere on campus, are available to graduate students in all four departments.

The School of Engineering houses a Data 100 medium-speed card reader and printer which communicates directly with the IBM 370-165 computer located at the Triangle Universities Computation Center in the nearby Research Triangle Park.

**Forestry Sciences Laboratory.** The U.S. Forestry Sciences Laboratory of the Southeastern Forest Experiment Station is located in the Research Triangle Park near Durham. This research organization provides excellent opportunities to complement research conducted by students in the Department of Forestry and Environmental Studies. Specialized research projects in forest entomology, pathology, physiology, and soils are currently underway at the laboratory. The staff of the laboratory is available for consultation and participation in seminars. Arrangements may be made for students to conduct certain aspects of their research at the laboratory.

**Duke Forest.** The Duke Forest serves as an outstanding field laboratory for the students and faculty of Duke University. This forest consists of nearly 8,000 acres on which grow various types of trees characteristic of the southeastern Piedmont region. Shortleaf pine, loblolly pine, and southern hardwoods represent the main timber types.

Much of the Duke Forest is adjacent to the campus and easily accessible, providing students and faculty with excellent opportunities to conduct studies in various fields of forestry such as ecology, entomology, land management, meteorology, pathology, physiology, and soils.

# Student Life







## Living Accommodations

Duke University offers varied living accommodations to married and single graduate students. A brief description of each follows.

**Graduate Center.** Only limited space in one residence hall is presently available for single students in the graduate and professional schools. This facility has been described as adequate and convenient; however, there are some disadvantages such as the lack of single rooms and private baths.

The Graduate Center, located near the Duke Medical Center, houses a limited number of graduate and professional school students, both men and women; the upper floors house undergraduates. Commons areas on the main floor and dining facilities on the ground floor are shared by all students who reside in the house.

The limited number of single rooms are usually reserved by previous occupants for the following academic year. Other rooms are equipped for two persons.

The Graduate Center closes during the summer sessions. Freshman medical students residing at the Graduate Center will be required to move to summer housing on West Campus after Commencement and to pay additional summer fees.

**Town House Apartments.** Town House Apartments, located in the Central Campus area, is a 32-unit complex, which also houses graduate and professional school students. These apartments are more spacious than the apartments found on campus or in Durham. Because of its location away from the academic facilities of the three campuses, students find that these apartments offer a change from normal campus life and activities. They are available for continuous occupancy, summer months included.

Some two-bedroom apartments are furnished for two single graduate students. The remaining apartments are furnished for three students. In each apartment for three students, choice of the single bedroom is determined by the occupants.

Each air-conditioned apartment includes a living room, master bedroom, one and one-half baths, a single bedroom, and an all-electric kitchen with a dining area. Spacious closets and storage spaces are provided within each apartment.

Occupants must make arrangements and pay for electricity, gas, and telephone service with the local utility companies. These companies usually require a deposit when initial applications for service are made.

**Central Campus Apartments.** During 1975, Duke University completed a 500-unit apartment complex. These units are available throughout the calendar year for continuous occupancy.

Apartments will be available for single and married students attending the graduate and professional schools and undergraduate colleges as well as all categories of students receiving instruction in the Allied Health Division of the Medical Center.

For single graduate and professional school students, one-bedroom and three-bedroom apartments are fully furnished; a few furnished efficiencies are also available. It is expected that many more applications will be received for efficiencies than can be accommodated.

**Application Procedure.** The Department of Housing Management provides students accepted to the University with housing application forms and detailed information on rates, rental agreements, and availability of housing. A completed and returned application form, accompanied by the required \$50 residential deposit, is necessary to be considered for assignment. Applications will be processed on a first-apply, first-assigned basis.

## Food Services

**West Campus and Graduate Center.** The dining facilities on West Campus include two cafeterias with multiple-choice menus. The Oak Room has waitress service and offers full meals and a la carte items. The Cambridge Inn, a self-service snack bar open throughout the day and evening, is located in the West Campus Union. The Graduate Center has a public cafeteria and a snack bar, Gradeli's, which is open until midnight.

**East Campus.** On the East Campus there are two dining halls which serve cafeteria-style meals. Although designed to serve residents on East Campus board plans, all other students may purchase meals there at the guest rate. Because of the large number of students served in the dining halls, it is not possible to provide special diets.

The cost of meals to non-board students approximates \$3 to \$4 per day, depending on the needs and tastes of the individual.

## Services Available

**Medical Care.** The aim of the University Health Service is to provide any medical care and health advice necessary to the student as a member of the University community. The Health Service maintains the University Health Services Clinic located in the Pickens Building on West Campus and the University Infirmary on the East Campus. Emergency transportation can be obtained by the Duke Campus Police. A separate fee for the University Health Service is assessed.

The Student Health Service offers varied benefits. To secure them, full-time graduate students must be in residence; during the fall and spring semesters, they must be registered for at least 9 units per semester until they have passed the doctoral preliminary examination, after which they must be registered for at least 3 units in residence. In the summer session, a student must be registered for at least 1 unit of research or 3 units of course work.

The University Health Services Clinic offers the student outpatient services, routine laboratory and X-ray examinations in the clinic for the treatment of acute



illness or injury, and advice and assistance in arranging consultation for medical treatments. Fees for such consultations or treatments must be paid by a student who is not covered by an insurance plan.

The facilities of the University infirmary are available to all currently enrolled full-time students in residence during the regular academic year. Hospitalization in the University infirmary is provided for treatment of acute illness or injury as authorized by the University Health Services Clinic physician. Students are required to pay for their meals while confined to the infirmary.

The Student Mental Health Service, located in the University Infirmary Building, East Campus, provides evaluations and brief counseling and/or treatment of matters ranging from questions about normal growth and development to the most serious psychiatric disorders. A student may have up to four appointments per year with the Student Mental Health Service at no charge. Further interviews can be arranged, either with this staff or with other professionals, at a fee commensurate with the student's ability to pay.

The resources of the Duke University Medical Center are available to all Duke students and their spouses and children, although any bills incurred at Duke Hospital or any other hospital are the responsibility of the student, if not covered by an insurance plan. The Student Health Program does not provide health care for spouses and dependent children of married students. Coverage of the married student's family is provided in the University's Student Accident and Sickness Insurance Plan for an additional fee.

The University has made arrangements for a Student Accident and Sickness Insurance Plan to cover all full-time students for a twelve-month period. For additional fees a student may obtain coverage for a spouse and a child. Although participation in this program is voluntary, the University requires all graduate students to be financially responsible for medical expenses above those covered by the University Student Health Program through the University Accident and Sickness Policy, a private policy, or personal financial resources. Students who have equivalent medical insurance or wish to accept the financial responsibility for any medical expense may elect not to take the Duke Plan by signing a statement to this effect. *Each full-time student in residence must purchase this student health insurance or*



indicate the alternative arrangement. The Student Accident and Sickness Insurance Policy provides protection twenty-four hours per day during the full twelve-month term of the policy for each student insured. Students are covered on and off campus, at home, while traveling between home and school, and during interim vacation periods. The term of the policy is from the opening day of school in the fall. Coverage and services are subject to change each year as deemed necessary by the University in terms of costs and usage.

**The Duke University Counseling Center.** Through the Counseling Center, the University provides a professional counseling service designed to aid students in gaining a better understanding of themselves and the opportunities available to them. Counseling is available in the areas of career planning, educational opportunities, and personal and social adjustment.

The center maintains files of educational and vocational information related to career planning, graduate educational programs and fellowships, and study aids.

National and University-wide testing programs are administered by the center. The staff conducts continuing research in counseling and testing.

**Office of Placement Services.** Duke University maintains an Office of Placement Services which acts as a liaison between the University and potential employers in business and industry, education, and government. All services are offered without charge to Duke students and alumni. The staff is available to talk with graduate students about their future professional plans. Graduate students who wish to register with the office are offered an opportunity to assemble a complete dossier of academic records and recommendations to supplement applications for positions, and to have a permanent file for future reference. Pertinent recommendations should be accumulated while the student is enrolled at Duke. Interviews with representatives visiting Duke are scheduled throughout the year for students registered with the Office of Placement Services.

## Student Affairs

**Cocurricular Activities.** Graduate students at Duke University are welcome to use such University recreational facilities as swimming pools, tennis courts, and golf course, and to affiliate with the choral, dance, drama, music, and religious groups. They may become junior members of the American Association of University Professors and may affiliate with Phi Beta Kappa and social fraternities. Graduate women and wives of graduate students may join the Graduate Women's Club.

A full program of cultural, recreational, and religious activities is presented by the Associated Students of Duke University, the Office of Cultural Affairs, the Duke University Christian Council, the Duke University Parish Ministry, the Duke University Union, the Office of Student Activities, and recreational clubs. Most programs are open to the entire University community. Inquiries should be directed to the ASDU Office; Duke Chapel; the Office of Cultural Affairs, 107 Page Building; the Duke University Union, 207 Flowers Building; or the Student Activities Office, 204 Flowers Building.

The Information Center, Page Box Office, publications offices, art gallery, meeting rooms, lounges, and recreational facilities are located in the Flowers and Union Buildings.

Full information regarding the scheduling of major events and programs for the entire year will be found in the Duke University *Annual Calendar*; detailed and updated information in the *Weekly Calendar*, available each Friday; and the *Duke Chronicle*, published each Monday through Friday. Copies may be obtained at the Information Desk or the Calendar Office, Page Building.

**Graduate Student Association.** The Graduate Student Association provides a formal means of communication between the graduate student body and the fac-

ulty and administration. Membership in the association is open to all registered graduate students. This student-organized association meets monthly, with representatives present from the graduate enrollment of each department. It is governed by a steering committee elected annually from the membership and, among other functions, provides graduate student representation on campus committees including those concerning the library, housing, and governance.

## Research and Publications

The departments of Duke University are devoted to research as well as to instruction. Since a prime purpose of the University is the promotion and diffusion of knowledge, attention in the Graduate School is focused on research and publication. To this purpose, the Provost annually appoints a University Research Council which receives applications from members of the various faculties for subsidies in support of research. The policy of this council is to encourage the initiation and completion of substantial research projects.

The Duke University Press was created in 1925 as a successor to the Trinity College Press. It continued the publication of the *South Atlantic Quarterly*, published at Trinity College since 1902, and in 1926 it revived the *Hispanic-American Historical Review*, which had been founded and published from 1918 to 1922 by a group of scholars interested in Hispanic America. In 1929 *American Literature* was begun with the cooperation of the American Literature Group of the Modern Language Association. This journal was followed in 1931 by *Ecological Monographs*, and in 1932 by *Character and Personality* (since 1945 entitled the *Journal of Personality*). In 1935 the press began the publication of the *Duke Mathematical Journal*. Since 1948 it has published *Ecology*, the official journal of the Ecological Society of America. It began publishing *American Literary Scholarship* (an annual) in 1965, the *History of Political Economy* in 1969, and the *Journal of Medieval and Renaissance Studies* in 1971. The press has since assumed the publication of the *Bulletin of the Ecological Society of America* (1970) and *Law and Contemporary Problems* (1975), formerly published by the School of Law. Publication of the *Journal of Health Politics, Policy, and Law* began in 1976.

Since its organization the press has published over five hundred volumes. These include seven series: the Duke Historical Publications; the Duke Studies in Religion; the publications of the Lilly Endowment Research Program in Christianity and Politics; those of the Program in Comparative Studies on Southern Asia; Monographs in Medieval and Renaissance Studies; publications of the Consortium for Comparative Legislative Studies; and, largest of all, with forty-two volumes to date, the publications of the Duke University Center for Commonwealth and Comparative Studies. In the broadest sense, the policy of the press is to make available to the public any scholarly work that merits publication, although special attention is given to works in fields of knowledge cultivated by the University.

## Visiting Scholars

The libraries and other facilities of Duke University are made available, to the extent practicable, to faculty members of other colleges and universities who wish to pursue their scholarly interests on the Duke campus. Identification cards are furnished visiting scholars by the Graduate School Office. Such visitors are not charged unless they wish to participate in activities for which a special fee is assessed. Assistance in finding housing is available from the Department of Housing Management. Inquiries pertaining to visiting scholars should be addressed to the department chairman concerned or the Dean of the Graduate School.



# Admission







## Students Requiring Admission

Admission is required of all students who intend to pursue study toward a degree offered by the Graduate School and of all other students who register as *special students* in the summer session. Students who have discontinued a program of study after earning a master's degree at Duke must, by letter, request permission of the Dean to undertake a doctoral program. All applicants are considered without regard to race, color, religion, sex, or national origin.

## Prerequisites

A student seeking admission to the Graduate School of Duke University must have received an A.B. or B.S. degree (or the equivalent in the case of foreign students) from an accredited institution. The student's undergraduate program should be well rounded and of such quality as to give positive evidence of capacity for graduate study. Usually the student should have majored in the area of intended graduate study; many departments (see the chapter on Courses of Instruction) list specific prerequisites. Students are urged to anticipate the language requirement and are reminded that Educational Testing Service Graduate School Foreign Language tests in French, German, Russian, and Spanish are offered to undergraduate and graduate students at many centers on nationally uniform dates (see Language Requirements).

## Procedures

A student seeking admission to the Graduate School should obtain an application blank from the Dean of the Graduate School. This should be filled out completely and returned promptly. Each application must be accompanied by a nonrefundable fee of \$15\* in check or money order payable to Duke University. In addition, the student should provide the following supporting documents: (1) two copies of the official transcript from each college, university, or seminary attended

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\*All fees are based on current charges and are subject to change without notice.

sent directly to the Dean by the institution; (2) two supplementary transcripts, sent as soon as possible, showing completion of work which was in progress when the earlier transcript was made; (3) three letters of recommendation written, on the forms provided, by persons best qualified to judge the applicant as a prospective graduate student and mailed directly to the Dean; (4) scores on the Graduate Record Examination Aptitude Tests for applicants to all departments; and (5) scores on the Graduate Record Examination Advanced Test for applicants to programs in biochemistry, botany, chemistry, English, geology, mathematics, microbiology, pathology, physics, physiology, Romance languages, sociology, and zoology.

Applicants to the Department of Health Administration are required to take the Graduate Management Admission Test, administered by the Educational Testing Service.

Students applying for financial aid in all departments should take the Graduate Record Examination no later than the October testing date in order to meet the February 1 deadline. Information on the times and places of the Graduate Record Examinations can be provided by the applicant's college or the Educational Testing Service, Princeton, New Jersey 08540, or Berkeley, California 94704.

**Additional Procedures for Foreign Students.** Fully qualified students from outside the United States are welcome to take courses in the Graduate School and, in many instances, to study toward a degree. In applying for admission the foreign student must, in addition to the information required of all students, submit with the application material (1) if the student's native language is not English, certification of English proficiency demonstrated by scores from the Test of English as a Foreign Language (TOEFL), administered through the Educational Testing Service in Princeton, New Jersey; (2) a statement showing financial arrangements for the proposed term at Duke (estimated costs per calendar year are \$6,800†); and (3) a statement by a qualified physician describing any emotional or physical illness the applicant has had during the previous five years. A foreign student must meet all these requirements before the Graduate School will make any offer of admission.

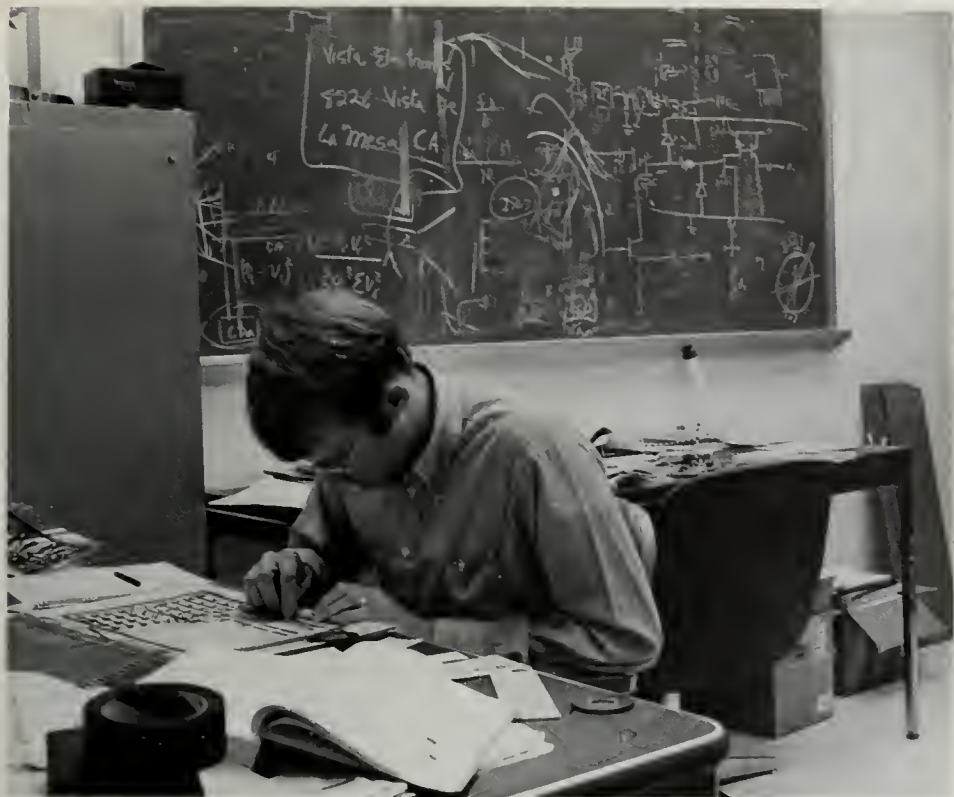
All foreign students whose native language is not English will be tested during their first registration period for competence in the use of oral and written English. Until such competence is determined, admission and arrangements for an award involving teaching must remain provisional. Students found to lack necessary competence will be required to enroll in the noncredit course called English for Foreign Students and to reduce their course or research program by 3 units. Tuition charge for this course will be \$53.50† per unit. Students who do not successfully complete this course during the first year of residency will not be permitted to continue their graduate work at Duke University. Passing this examination or, if it is required, the course, will not meet degree requirements for a foreign language. (See Language Requirements for Foreign Students.)

**Notification of Status.** When admission is approved, the student will receive a letter of admission and an acceptance form. The process of admission is *not complete* until the acceptance form has been returned. An admission offer is for the semester specified in the letter of admission.

Applicants who are admitted will be offered full admission, provisional admission, or nondegree admission. *Provisional admission* for a trial period of one semester or a minimum of 12 hours of course work is offered to students who appear to warrant admission but do not fully comply with admission requirements. Graduate credit earned under provisional status may be applied toward an advanced degree at Duke University if and when the student is granted full admission. *Nonde-*

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†Figures are based on 1976-1977 charges and are subject to change before the fall, 1977, semester.



gree admission is offered to students who meet the admission requirements and who desire to engage in graduate study not subject to the restrictions of a graduate degree program. With the approval of the student's major department and the Dean of the Graduate School, a maximum of 6 units of credit earned under nondegree status may be applied toward an advanced degree at Duke University if and when the student is granted full admission. (See ruling on page 25.)

**Deadlines for Application.** It is the applicant's responsibility to make certain that the Graduate School Office has received all required material before the specified deadlines. Because applications cannot be reviewed until all supporting documents are filed, applications should be submitted at least *two weeks* before the closing dates listed below:

Fall semester, admission and award .....	February 1
Fall semester, admission only .....	July 15
Spring semester, admission only .....	November 1
Summer session, 1978* first term .....	April 15
Summer session, 1978* second term .....	May 15
Summer session, 1978* third term .....	June 15

Anyone whose folder is not complete before the appropriate date will face the possibility that departmental enrollment will have been filled. Although the Graduate School Office will process all applications, it can not guarantee full consideration of a folder for any department after April 15.

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\*Students seeking admission to the Graduate School for study in the summer session should make application to the Dean of the Graduate School as well as to the Director of Summer Programs.

# Financial Information







## Tuition and Fees\*

The 1976-1977 tuition for all students (except those in Health Administration and Physical Therapy) for a full semester program is \$1,605 (15 units at \$107 per unit). Part-time tuition is calculated at the same rate of \$107 per unit. Tuition charges are due and payable at the times specified by the University for that semester and are subject to change without notice. Registration is not considered complete, and students may not be admitted to classes, until arrangements have been made with the Bursar of the University for the payment of tuition and fees. A late registration fee of \$25 is charged any student not completing registration during the registration periods. The *in absentia* fee is due on the date specified by the University and is subject to the late registration fee if not paid by that date. The fee is \$107 for 1 unit per semester.

Students passing the preliminary examination may obtain a reduction in their registration and tuition fee at any time during the five-week period beginning on registration day. No other refund in fee may be obtained. A reduction in registration necessitated by changes in departmental service requirements for assistants may be made during the first two weeks of classes, with the approval of the Dean. Any fee reduction for this reason is credited to future registration fees. In the event of death or involuntary call to active military duty, refunds will be made on a pro rata basis. In all other cases of withdrawal, students or their parents may elect to have tuition and room and board charges refunded or carried forward as a credit for later study, according to the following schedule:

1. Withdrawal before classes begin: full refund;
2. Withdrawal during the first or second week of classes: 80 percent;
3. Withdrawal during the third, fourth, or fifth week of classes: 60 percent;
4. Withdrawal during the sixth week: 20 percent;
5. Withdrawal after the sixth week: no refunds.

Tuition or other charges paid from grants or loans will be restored to those funds, not refunded or carried forward.

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\*The figures contained in this section are based on 1976-1977 charges and are subject to change prior to the beginning of the fall, 1977, semester.

**Thesis or Dissertation Fees.** Fees incurred in connection with thesis or dissertation are as follows:

* Binding fee, three copies of thesis or dissertation, other copies optional at \$5.50 per copy.....	\$16.50
Microfilming fee, doctoral degree only, upon final submission .....	\$30.00
Copyright fee (doctoral degree only, optional).....	\$15.00

**Athletic Fee.** An athletic fee of \$25 for the year is optional and payable in the fall semester. The Treasurer of the University has sole responsibility for collection of fees and for arranging for the proration of fees.

**Special Tuition Rates for Teachers and Others.** The Graduate School recognizes a special obligation to encourage the following types of students in their professional and personal advancement: (1) faculty members and administrators of neighboring public schools and colleges currently engaged in *full-time* school work while taking courses in the Graduate School, (2) ministers of neighboring churches, (3) spouses of Duke faculty members, (4) *full-time* employees of Duke University who are paid on a biweekly or monthly basis *throughout* the year and have been employed for one year. The reduced tuition rates specified below do not apply to teachers and ministers while on leave of absence, to holders of fellowships, scholarships, or graduate and research assistantships, or to part-time instructors. Persons working toward a degree may not hold a faculty rank above that of instructor.

Persons eligible for the reduced tuition rate must meet the admission standards required of all graduate students and must be admitted to the Graduate School. They may enroll for one or two courses per semester (in no case totaling more than 7 units) upon payment of a fee of \$5 for registration for each semester and tuition of \$53.50 per unit of credit or an audit fee of \$40 per course. Residence requirements cannot be fulfilled at the reduced rate. Students enrolled in doctoral programs are not eligible for the reduced rate.

**Fee for Undergraduate Courses.** Graduate students registering for undergraduate courses will be assessed 3 units for a non-laboratory course and 4 units for a laboratory course.

**Audit Fee.** Registered students may audit without charge up to three courses per semester if they are registered for at least 15 units, or up to two courses per semester if they are registered for at least 9 units. Otherwise an audit fee of \$40 per course is charged.

**Vehicle Fee.** Each student possessing or maintaining a motor vehicle at Duke University shall register it at the beginning of the academic year in the Security Office at 2010 Campus Drive. A student who acquires a motor vehicle and maintains it at Duke University after academic registration must register it within five (5) calendar days after operation on the campus begins. Resident students are required to pay an annual fee of \$20 for each motor vehicle or \$10 for each two-wheeled motor vehicle. Resident students registering a vehicle for the first time after January 1 are required to pay \$14 for a motor vehicle or \$7 for a two-wheeled motor vehicle.

At the time of registration of a motor vehicle, the following documents must be presented: state vehicle registration certificate; valid driver's license; and satisfactory evidence of automobile liability insurance coverage, with limits of at least \$10,000 per person and \$20,000 per accident for personal injuries, and \$5,000 for property damage, as required by the North Carolina Motor Vehicle Law.

If a motor vehicle or a two-wheeled motor vehicle is removed from the campus permanently and the decal is returned to the Traffic Office prior to January 1,

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\* If more than one snap binder is required per copy of the dissertation, a deposit of \$3.50 will be collected for each additional snap binder.

there will be a refund of \$10 for a motor vehicle and \$5 for a two-wheeled motor vehicle.

**Transcript Fee.** Students who wish to obtain copies of their academic records should direct requests to the Registrar's Office. Ten days should be allowed for processing. A minimum fee of \$2, payable in advance, is charged for a single copy. When two or more copies are forwarded to a single address, a charge of fifty cents will be made for each additional copy.

**The Student Health Fee.** All students are assessed a fee for the Student Health Service. In 1976-77, the fee was \$70 (\$35 each semester).

**Debts.** No records are released and no students are considered by the faculty as candidates for graduation until they have settled with the Bursar for all indebtedness.

## Expenses\*

**Housing Fee.** The charge for each person in a double room for the academic year is \$520 in the Graduate Center. The fee for Town House Apartments, not including utilities, is \$650 per occupant for the academic year on the basis of three students to an apartment. Fees for single students and rental rates for married students in Central Campus Apartments will be quoted by the Manager of Apartments and Property.

Housing fees are subject to change prior to the 1977-1978 academic year. A \$50 deposit is required with all applications. No refund on housing fees is made to students who withdraw after the date of registration, except for those who withdraw involuntarily because of a call to active duty in the armed forces. Such refund will be made in accordance with the University's established schedules. For further information on housing facilities, see Living Accommodations in the chapter on Student Life.

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\*The figures contained in this section are subject to change prior to the beginning of the fall, 1977, semester.





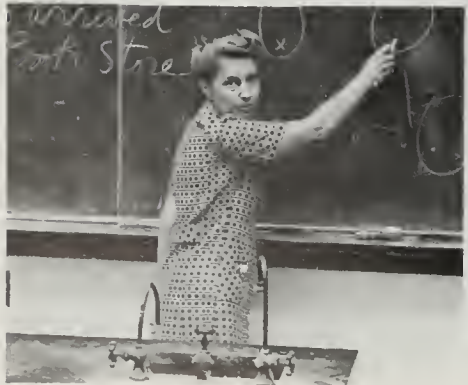
Food. Food service on both the East Campus and the West Campus is described under Living Accommodations in the chapter on Student Life. The cost of meals approximates \$900 to \$950 per year, depending upon the needs and tastes of the individual.

**Summary.** The table below represents an estimate of a graduate student's basic expenses for one academic year for a full program of work. These figures do not include allowances for recreation, travel, clothing, and other miscellaneous items which vary according to personal needs and tastes.

Tuition.....	\$3,210.00
Room Rent (Graduate Center).....	520.00
Board .....	830.00 to 900.00
Laundry .....	60.00
Books .....	200.00

Fellowships and Scholarships

**James B. Duke Fellowships.** The James B. Duke One-Hundredth Anniversary Fund provides fellowships for students who wish to pursue a program leading to





the Ph.D. degree in the Graduate School at Duke University. Its objective is to aid in attracting and developing outstanding scholars at Duke. Selection of recipients is made by a faculty committee upon nomination by the appropriate department. It is expected that approximately forty offers of this fellowship will be made for the coming year. These fellowships provide for payment of tuition for full registration during the academic year, plus *in residence* registration during the summer sessions. They also provide an income stipend of \$350 per month for twelve months over the three-year duration of the award. The award requires no service and is renewable each year upon evidence of superior performance in progressing toward the degree. The total value of a James B. Duke Fellowship over the three years of tenure for a student who passes the preliminary examination at the end of the second year is over \$20,000 at current tuition rates. There are forty-four James B. Duke Fellows currently enrolled.

**Endowed Fellowships.** Other special endowments provide fellowships for graduate study. The Angier B. Duke Fellowship provides support on the same level as the James B. Duke Fellowship for one student for the academic year. There are five Gurney Harris Kearns Fellowships in Religion ranging in value up to \$4,500. Selection for these fellowships is made through faculty committees. The E. Bayard Halsted Fellowship in science, history, or journalism is awarded to a graduate of Duke University intending to pursue an advanced degree at Duke. This fellowship, which is administered by the Graduate School, provides a monthly stipend plus tuition to an outstanding graduate student working in a broad area of science, history, or journalism. The Frank T. de Vyver Fellowship, administered by the Department of Economics, is awarded each year to an outstanding student entering the doctoral program in Economics. The Clare Hamilton Memorial Endowed Fellowship, a gift of the Hamilton family in memory of their daughter, is awarded yearly on the basis of merit and need to one or more outstanding students in clinical psychology. The stipend of \$3,000 may be used to defray tuition and/or living expenses while the student is engaged in graduate study. Relatives and friends of the late Professor Charles R. Hauser established the Charles R. Hauser Fellowship to be awarded to an outstanding graduate student in the last year of work toward a Ph.D. degree in chemistry. The Department of Chemistry administers this fellowship, which is awarded to a student working in the area of organic chemistry. The Calvin Bryce Hoover Fellowship, established in honor of the late Professor Calvin Bryce Hoover, is administered by the Department of Economics and is awarded each year to an outstanding student entering the doctoral program in economics. The Robert R. Wilson Fellowship in the Department of Political Science is awarded to a student currently enrolled in, or entering, a doctoral program in international law, international organization, or international relations. This endowed fellowship is administered by the Department of Political Science. The Gertude Weil Fellowship, administered by the Department of Religion, is awarded to students interested in Judaic studies.

**Graduate Fellowships.** Graduate Fellowships funded by Duke University are available to students in the Graduate School for study during the academic year. Stipends, which include tuition, range from \$3,000 for the academic year to \$6,600 for a full calendar year. In 1976-1977, sixty-eight students held these fellowships.

**Federal Fellowships.\*** Duke University participates in the following programs:

*National Defense Education Act, Title VI Fellowships.* The purpose of this program is to encourage persons to undertake advanced training in modern foreign languages and in related area studies not commonly taught in the United States.

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\*United States citizenship is generally a requirement for eligibility.

The world area in which National Defense Foreign Language (NDFL) Fellowships are offered at Duke University is Southern Asia. Fellows must engage in intensive study in a language of that world area during their tenure, as well as pursue work toward their degree. The fellowships carry academic-year stipends of \$2,000, \$2,200, or \$2,400, depending on the stage of graduate study, plus tuition and allowances of \$500 for each eligible dependent. In 1976-1977, three students at Duke University held NDFL Fellowships. Interested persons should write to the International Studies Center.

*National Science Foundation Fellowships.* A number of students hold National Science Foundation Graduate Fellowships which provide tuition plus an income stipend of \$3,900.

Other federal programs support fellowships, traineeships, and research assistantships through departmental auspices. Approximately 475 students were supported through these programs during 1976-1977.

**Fellowships in Medieval and Renaissance Studies.** Three fellowships are awarded annually by the Duke University Committee on Medieval and Renaissance Studies. Fellows are chosen from among students enrolled in Ph.D. programs. They receive full tuition, plus a monthly stipend of \$250 for nine months, and may request two renewals of the appointment.

**Special Fellowships.** The following special fellowships are available to qualified Duke students from sources outside the University:

*Shell Fellowships in African Studies.* These fellowships are available to qualified students in social sciences who are preparing for careers in the State Department, including the foreign services of the United States, the United Nations, or other international agencies, or in research and teaching in international affairs in academic institutions within the United States. They must be citizens of the United States or residing permanently in the United States and intending to become citizens. The fellowships are intended to cover the expenses of field research in the preparation of doctoral dissertations. The stipend for each fellowship is \$4,000 plus a reasonable amount for transportation expenses. Inquiries should be made to the Administrative Assistant, Center for International Studies, 2101 Campus Drive, Durham, North Carolina 27706.

*Cokesbury Graduate Awards in College Teaching.* These awards are sponsored by the Board of Education of the Methodist Church. They are designed to as-





sist graduate students who are committed to a Christian philosophy of higher education and who have been members of the Methodist Church for at least three years. Awards are for one year and vary in amount from \$500 to \$2,000. Applications must be completed before April 1. Further information and application forms may be obtained from the Dean of the Graduate School.

*Exchange Fellowships with the Free University of Berlin.* These fellowships are available through an exchange arrangement with the Free University of Berlin which will provide fellowships for two graduate students to study during the regular academic year in Berlin. Interested students should write to the Dean of the Graduate School prior to February 1.

**Departmental Fellowships.** Various departments and schools within Duke University have fellowships which are available to students pursuing graduate study. Information may be obtained from the individual departments.

**Graduate Scholarships.** Graduate Scholarships funded by Duke University are available to students in the departments of the Graduate School for study during the academic year. Awards are for full or partial payment of tuition; they range in value to \$3,280. In 1976-1977, eighty-one students held Graduate Scholarships.

**Summer Scholarships.** A small number of Summer Scholarships which provide a payment of \$400 are available to students engaged in full-time study during the summer session. Interested students should consult the appropriate director of graduate studies.





## Assistantships

**Graduate Assistantships.** Appointments as graduate assistants carry a total stipend of up to \$5,200 for the academic year. The value of the stipend is determined by the time spent in assisting, the qualifications of the assistant, and the nature of the work assigned. In 1976-1977, 202 students held Graduate Assistantships.

**Research Assistantships.** Appointments are for predoctoral candidates whose special training and qualifications enable them to serve as assistants to individual staff members in certain departments. Stipends may be up to \$5,200, depending on the nature of the assistance and the assisting time required. In 1976-1977, 215 students held Research Assistantships.

**Part-time Instruction.** Several departments offering graduate work have exceptionally qualified graduate students work as part-time instructors, tutors, and teaching assistants. These students may qualify to reduce their registration to 9 or 12 units per semester.

## Payment of Awards

The payment of income stipends to graduate students holding awards starts on September 30 and is made in nine equal payments on the last working day of each month thereafter. Research assistants being paid from funds through federal grants and contracts are paid on the twenty-fifth of each month. The Controller of the University has sole responsibility for paying all stipends to students.

Ordinarily, stipends awarded under fellowships, scholarships, and research assistantships are not subject to income or Social Security tax; however, a portion of the award to graduate assistants having teaching assignments may be subject to both. The Graduate School Office will supply detailed information.



## Loans

It is the policy of Duke University to provide loans when needed to help students meet their educational expenses. Only students with full-time status who can demonstrate need according to established guidelines are eligible for loans. Loan funds are provided through the Federal Insured Student Loan Program, the National Direct Student Loan Program, and funds solely under institutional control. Generally, loans made from these funds bear no interest charge to qualified borrowers while they maintain student status and for a short period thereafter. Interest during the repayment period is at a generally favorable rate. Any student wishing to apply for a loan must, as a first step, complete the student section of a Graduate and Professional School Financial Aid Statement (GAPSFAS) form. If this form has been completed in connection with a loan application to another institution, the student may request that a copy of the analysis be sent to the Graduate School instead of completing the form a second time. An analysis of financial need will be made on the basis of the information from the GAPSFAS form. Additional information may be required of students who do not qualify as financially independent of their parents. GAPSFAS and other forms which accompany loan applications may be obtained on request from the Graduate School Office. Loan applications should be made prior to June 1 for the subsequent academic year.

## Work-Study Program Employment

Limited funds are available through the College Work-Study Program for short-term or part-time employment of graduate students. Eligibility requirements are similar to those of the federal loan programs. These funds are also used in conjunction with the Graduate School Research Technician Program which provides over fifty students doing research in their own specialized area each summer with employment for four or more weeks. In addition to this program and to departmental employment opportunities, the Placement Office maintains a listing of employment openings for students.

# Registration and Regulations





## Registration

**Who Must Register.** All students who are enrolled in the Graduate School in any program and who have not been granted a leave of absence by the Dean must register each semester until all degree requirements are completed.

**Registration Periods.** After receiving notification of admission to the Graduate School and returning a statement of acceptance of admission, the student must register for the term indicated in the admission letter. A student first confers with the director of graduate studies of the major department, who prepares and signs a course card listing the course work to be taken during the semester. The student then presents this course card to registration officials for enrollment in the selected courses. After the first registration, a student must register for subsequent semesters at the regular stated time for registration. Currently enrolled students who fail to register at the first scheduled registration period for the subsequent semester incur a penalty for late registration. *Former students* who intend to register to resume a degree program must give the department and the Dean notice of this intention two months before registration.

**Late Registration.** All students are expected to register at the times specified by the University. A late registration fee of \$25 is charged any student registering late, including a current student who delays registering until the special registration for new students.

**Change of Registration.** During the first two weeks of the semester, registration may be changed with the approval of the director of graduate studies, if no reduction of fee is entailed. If fees are to be refunded, the approval of the Dean of the Graduate School is required. For the succeeding two weeks, courses may be dropped and equivalent hours of research or residence credit added with the approval of the director of graduate studies, the instructor of the course, and the Dean. Students who pass the preliminary examination during the first five weeks of a semester may alter their registration with fee adjustments at any time during that period.

## Academic Regulations

**Residence.\*** Although graduate study consists principally of individual reading, research, and laboratory experimentation under guidance, academic progress in the United States is generally measured and recorded in terms of course hours and credits. Credit for courses, seminars, research, and residence, and corresponding tuition and fees are stated in terms of units. One unit is equivalent to one semester hour. The term *residence* designates full-time study and research in close proximity to the facilities provided, as opposed to part-time study incidental to a full-time occupation. For purposes of satisfying the residence requirement of the various degrees, residence of one year is defined as two successive academic semesters of no fewer than 9 units each semester. (See chapter on Graduate Study in the Summer Session for residence required of master's candidates engaged solely in summer study.) Each student must register for a full program until the preliminary examination is passed.

**Faculty Ruling.** No member of the instructional staff who is a candidate for a degree in the Graduate School of Duke University may hold a faculty rank above that of instructor.

**Course Load.** Graduate students are considered fully registered when they enroll for the number of credits their programs require. Required registration is set in consideration of a student's obligation to teach or assist and of a student's progress toward fulfilling degree requirements. In the academic year normal registration for the *resident doctoral* student who does not hold an appointment as part-time instructor or assistant and does not engage in part-time work, is 15 units a semester or 30 units an academic year. The registration for *resident doctoral* students who hold such appointments or undertake such work is either 12 units or a minimum of 9 units, depending upon the number of hours a week they are required to devote to such duties. Resident doctoral students carry full registration through the semester in which they pass the preliminary examination. If they remain in residence, they continue to register for a minimum of 3 units each semester until the dissertation is accepted. Those who elect to go out of residence (away from the University) register for 1 unit each semester *in absentia* in order to keep their program active.

The registration requirements for a resident student pursuing a master's degree are the same as those for a student pursuing the doctorate. A student who has completed all requirements except the thesis, and has not matriculated in a doctoral program at Duke, may register for as few as 3 units per semester. A student who decides to go out of residence (away from the University) registers for 1 unit *in absentia*. Regulations pertaining to a resident student enrolled in a master's program requiring no thesis are identical to those described above for doctoral students, up to and including the semester in which the course requirements are satisfied. At that point, the registration may be reduced to the number of units necessary for completion of the degree program.

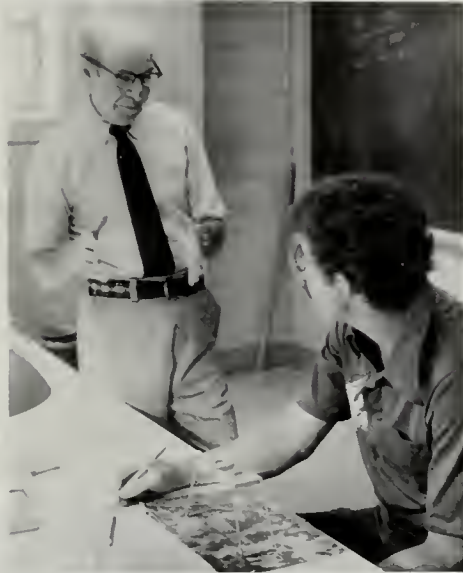
In each term of the summer session, 6 units is the maximum registration. Students who are in residence during the academic year and wish to continue study and to use University facilities, including the Student Health Service, during the summer, must register for 1 unit in the first summer session term. This registration provides use of facilities for all three terms of the summer session.

The registration of 1 unit a semester *in absentia* provides occasional consultation with the thesis or dissertation supervisor. It may be waived for serious problems of health.

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\*See also section on Program Information.





It is necessary to be a fully registered student according to the regulations listed above in order to establish eligibility for library carrel and laboratory space, student housing, University and some outside loans, and the Student Health Service, including accident and sickness insurance. (See the chapter on Student Life.)

**Credits.** The following regulations pertain to credits earned outside the Duke University Graduate School:

*Graduate Credit Earned before the A.B. Degree is Granted.* Ordinarily no credit will be allowed for graduate courses taken before a student has been awarded the A.B. or B.S. degree. However, undergraduate students at Duke University, who at the beginning of their final semester lack no more than 9 semester hours of fulfilling the requirements for the A.B. or B.S. degree, may obtain permission from the Dean of the Graduate School to enroll for graduate courses to bring their total programs to 15 hours a week. Such graduate courses may be credited toward the A.M., M.S., M.H.A., M.Ed., or M.A.T. degree, provided that the student meets the requirements for admission to the Graduate School and is duly registered in the Graduate School at the beginning of the semester in which graduate credit is to be earned.

*Transfer of Graduate Credits.* Transfer of credit for graduate course work completed at another institution will be considered only after a student has earned

a minimum of 12 units of graduate study at Duke University. After completing the 12 units, the student should file a request for transfer of credits on the appropriate Graduate School form.

**Graduate Credit for Courses Taken in the School of Law.** Upon recommendation of the director of graduate studies, and approval of the Dean of the Graduate School, a student in the social sciences may take certain courses in the School of Law for graduate credit. In some instances, courses in the School of Law may be considered as fulfilling requirements for related work. To register for such courses, a student should present a letter from the director of graduate studies in the major department to the Dean of the School of Law requesting permission to register for specific courses.

**Reciprocal Agreements with Neighboring Universities.** Under a plan of cooperation between Duke University and the University of North Carolina at Chapel Hill, North Carolina Central University in Durham, and North Carolina State University at Raleigh, students properly enrolled in the Graduate School of Duke University during the regular academic year, and paying full fees to this institution, may be admitted to a maximum of two courses per semester at one of the other institutions in the cooperative plan. Under the same arrangement, students in the graduate schools in the neighboring institutions may be admitted to course work at Duke University. All inter-institutional registrations involving extra-fee courses or special fees required of all students will be made at the expense of the student and will not be considered a part of the Duke University tuition coverage.

**Identification Cards.** Graduate students are issued two-part identification cards which they should carry at all times. The cards are the means of identification for library privileges, athletic events, and other University functions or services open to them as University students. Students will be expected to present their cards on request to any University official or employee. The cards are not transferable, and fraudulent use may result in loss of student privileges or suspension. A student should report the loss of a card immediately to the Registrar's Office. The cost of a new ID card is \$5.

**Grades.** Grades in the Graduate School are as follows: *E*, *G*, *S*, *F*, and *I*. *E* (exceptional) is the highest mark; *G* (good) and *S* (satisfactory) are the remaining passing marks; *F* (failing) is an unsatisfactory grade; and *I* (incomplete) indicates that some portion of the student's work is lacking, *for an acceptable reason*, at the time grades are reported. The instructor who gives an *I* for a course specifies the date by which the student must make up the deficiency, in no case more than one calendar year from the date the course ended. If the course is not completed, the grade of *F* is normally entered upon the student's record. The grade of *Z* indicates satisfactory progress at the end of the first semester of a two-semester course. A grade of *F* in a major course normally occasions withdrawal from a degree program not later than the end of the ensuing semester or term; a grade of *F* in any other course occasions academic probation.

**Courses Primarily for Undergraduates.** Students granted provisional admission and others whose preparation is found deficient may occasionally be required, as part of their program, to take undergraduate courses as prerequisites to continued graduate study. Undergraduate courses thus taken and others elected by the student carry no credit toward a degree.

In exceptional cases, 100-level courses outside the major department may be taken for degree credit to a maximum of two one-semester courses or one year course not exceeding a total of 8 units, when approved by the directors of graduate studies in the major department and in the department in which the course is listed, and by the supervisor of the program. In order to receive credit for any such undergraduate work, the graduate student must earn a grade of at least *B*. Gradu-

ate students registering for undergraduate courses will be assessed 3 units for a non-laboratory course and 4 units for a laboratory course.

**Withdrawal from a Course.** For permissible changes during the first four weeks of a semester, see Change of Registration. If a course is dropped without the necessary approval, the permanent record will list the course as *Dropped Unofficially, F*. If a course is dropped after the four-week period, the status of the student at the time of withdrawal from the course will be determined and indicated on the permanent record as *Withdrew Passing (WP)* or *Withdrew Failing (WF)*.

**Interruption of Program and Withdrawal from the Graduate School.** The University reserves the right, and matriculation by the student is a concession of this right, to request the withdrawal of any student whose academic performance at any time is not satisfactory to the University. A student who wishes for any reason to withdraw from the Graduate School should notify in writing both the director of graduate studies in the major department and the Dean of the Graduate School prior to the date of the expected withdrawal. (For refunds upon withdrawal, see the section on Tuition and Fees.)

A student who, after successfully completing one semester of graduate study, must withdraw before completion of a graduate program may, with the approval of the major department, request the Dean to issue a Certificate of Graduate Study.

**Leave of Absence.** A leave of absence for a period of time no longer than one calendar year may be granted because of medical necessity, full-time employment at Duke University, or acceptance of an external award judged likely to benefit the student as an individual but not related to the degree requirements. A request for a leave of absence should be originated by the student, endorsed by the student's major professor and director of graduate studies, and submitted to the Dean of the Graduate School for consideration. A student is eligible to request a leave of absence only after having completed at least one semester at Duke. Time limitations which pertain to the various degrees and the completion of courses on which a grade of *I* (incomplete) was earned are not waived.





**Size and Make-up of Classes.** Classes which carry graduate credit are limited in size to thirty students. In exceptional cases this regulation may be modified, but only by permission of the Dean of the Graduate School. Courses numbered from 200 through 299 may have not only graduate students enrolled, but also an unspecified number of sophomores, juniors, and seniors, provided the undergraduates have the approval of both the instructor of the course and the director of graduate studies. Undergraduate students are not permitted to enroll in 300-level courses.

**Language Requirements.** Although individual departments have the right to establish their own minimal requirements (see individual departmental sections in this *Bulletin*), the regulations of the Graduate School require no language for the master's degree, and, in most departments, a reading knowledge of one foreign language, ancient or modern, for the Ph.D. degree. With the special approval of the Dean and of the Executive Committee of the Graduate Faculty, the foreign language requirement for the Ph.D. degree may be waived in individual cases or with respect to all students in a given department, provided the department submits satisfactory evidence that a foreign language has little bearing on the major program of the students concerned. The languages usually taken are French, German, and Russian. A student may substitute another language which has a definite relation to the degree program and for which an examination can be provided. A foreign student whose native language is not English may request that the director of graduate studies in the major department ask permission of the Dean of the Graduate School to offer English for the foreign language required for the degree.

To avoid unnecessary delays, prospective students should anticipate the language requirement of their degree programs. For example, a student whose program requires a knowledge of French, German, Russian, or Spanish is urged to take the appropriate Educational Testing Service (ETS) Graduate School Foreign Language Test prior to registration. It should be noted, however, that at the time of the final examination in a master's program or of the preliminary examination in a doctoral program, language examinations more than six calendar years old will not be accepted toward fulfilling the language requirement.

**Meeting the Requirement.** The foreign language requirement may be satisfied in the following ways:

1. The student may take one of the ETS examinations administered to undergraduate and graduate students at many national centers (including the Duke University Counseling Center). The examination may be taken no earlier than six years before the preliminary examination.





2. With the permission of the Dean of the Graduate School, the director of graduate studies may request acceptance of a language examination passed prior to the student's enrollment at Duke. The student should request that a transcript or other certification that the language examination was passed be sent to the Graduate School for approval. Requirements are (a) that only one language of a doctoral requirement be met in this way, (b) that the other institution offer a doctoral program in the student's major and the examination would have met a doctoral requirement there, and (c) that the examination have been passed no more than five years before first registration at Duke.

3. In a language for which ETS tests are not available, a reading examination may be arranged by the Graduate School Office and administered by a qualified examiner.

4. In special circumstances, a reading examination in any foreign language may be administered by a qualified member of the faculty under a procedure specified by a department and approved by the Dean and the Executive Committee of the Graduate Faculty.

*Requirements for Foreign Students.* Foreign students whose native language is not English are, during their first registration period, required to take a test for minimum competence in English. Such students, with the approval of the director of graduate studies in their major department, may request permission of the Dean of the Graduate School to substitute English for the one foreign language required in the master's or doctoral program. (See Admission Procedures for Foreign Students.)

**Special Reading Courses.** Special courses designed to assist graduate students in acquiring a reading knowledge of French or German are offered for three hours a week: French during the fall semester and occasionally in the spring semester, and German during the spring semester and the summer session. Students who register for either course must reduce their normal load of graduate courses by 3 units, with no reduction in fees. Auditors are not permitted in these courses. Undergraduates may not enroll in these special courses during the academic year but may register in the summer with permission of the Dean of the Graduate School, provided space is available after graduate students have been enrolled.

**Undergraduate Language Courses.** Graduate students receive no credit for language courses numbered below 200.

## Commencement

Graduation exercises are held once a year, in May, when degrees are conferred on, and diplomas are issued to, those students who have completed requirements by the end of the spring semester. Those who complete degree requirements by the end of the fall semester or by the end of a summer term receive diplomas dated December 30 or September 1, respectively. There is a delay of about one month in the mailing of September and December diplomas because diplomas cannot be issued until they are approved by the Academic Council and the Board of Trustees.

## Standards of Conduct

Duke University expects and will require of all its students cooperation in developing and maintaining high standards of scholarship and conduct.

The University wishes to emphasize its policy that all students are subject to the rules and regulations of the University currently in effect or which, from time to time, are put into effect by the appropriate authorities of the University.

**Judicial Code and Procedures.** In the spring of 1971, the Graduate School community ratified and adopted the following official judicial code and procedures:

## **I. Graduate School Judicial Code and Procedures**

A. A student, by accepting admission to the Graduate School of Duke University, thereby indicates his willingness to subscribe to and be governed by the rules and regulations of the University as currently in effect or, from time to time, put into effect by the appropriate authorities of the University, and he indicates his willingness to accept disciplinary action, if his behavior is adjudged to be in violation of those rules or in some way unacceptable or detrimental to the University. However, a student's position of responsibility to the authorities and the regulations of the University in no way alters or modifies the responsibilities that are his in relation to civil authorities and laws.

B. A graduate student at Duke University stands in a primary and unique relation of responsibility to the faculty in his major department, the faculty upon whose recommendation a graduate degree will or will not be awarded to the student. In matters which involve or may affect the student's intellectual or professional life, the student is directly responsible to this department and its representatives, and such matters should primarily be handled by the department.

C. Actions which appear to conflict with University-wide rules and regulations will fall under the jurisdiction of the University Judicial Board.

D. A student may elect to have the Dean of the Graduate School hear matters related to the student's conduct in addition to or instead of faculty members from the student's major department, or he may elect to have such matters reviewed and judged by a judicial board instead of the Dean of the Graduate School or members of the faculty in his major department. (The constitution and procedure of the judicial board are detailed below).

E. The Director of Graduate Studies in the student's major department may request that a student's actions be reviewed by the Judicial Board or by the Dean of the Graduate School.

## **II. The Graduate School Judicial Board**

A. *Composition.* The Graduate School Judicial Board shall have five members, serving for a period of two years: two students selected from the student body, two members of the Graduate Faculty appointed by the Executive Committee of the Graduate School, and one Associate or Assistant Dean appointed by the Dean of the Graduate School. The Board shall elect one of its members as Chairman. The Board shall have at its service a recording secretary to keep minutes of the hearings and of the Board's actions in a permanent, confidential record book. The Board will be constituted in order to hear cases in which the accused is a student currently enrolled in the Graduate School and which have been referred to it by the Director of Graduate Studies in the student's department, by the Dean of the Graduate School, or by the student himself.

B. *Preliminary Procedures.* If a student requests a hearing by the Judicial Board he must do so in writing, allowing its chairman at least 72 hours to convene the Board. In addition, the chairman shall not convene the Board until 72 hours after he has been asked to convene the Board. It is the responsibility of the Chairman of the Judicial Board fully to inform its members concerning the case and the reasons the case has been referred to the Board. In addition, he shall prepare a written summary of this information for the Board, the Dean, and the student.

C. *Procedural Safeguards for the Hearing.* The Accused has the right to challenge any member of the Judicial Board on grounds of prejudice. If the Board decides to excuse one or more of its members for reasons given by the Accused, it shall consult with the Dean about the need for replacements. The Accused may choose an Advisor to assist him in his defense. He may also produce witnesses (including no more than two character witnesses), introduce documents, and offer testimony in his own behalf. A person having direct knowledge relevant to a case being heard by the Board is a material witness. The Judicial Board may request the appearance of material witnesses. The Board shall also request, upon written request of the Complainant or the Accused, the appearance of material witnesses. Witnesses shall be notified of the time, place, and purpose of their appearance. The Accused has the right to examine the written statement of any witness relevant to his case at least 72 hours before the hearing. He has the right to be faced with any witness who has given a statement relevant to his case at the hearing if the witness's attendance can be secured.

The hearing will be conducted in private unless the Accused requests an open hearing. If any objection is raised to conducting an open hearing in any particular case, the Judicial Board shall decide the issue by majority vote. If the decision is made not to hold an open hearing, the Accused shall be informed in writing of the reasons for the decision.

The Judicial Board shall consider only the report of the Chairman, documents submitted into evidence, and the testimony of witnesses at the hearing in reaching its decisions.

D. *Conduct of the Hearing.* The hearing of any case shall begin with a reading of the charge by the Chairman in the presence of the Accused. The Accused shall then plead guilty or not guilty or move to terminate or postpone the hearing. The Accused may qualify a plea, admitting guilt in part

and denying it in part. The Accused may not be questioned for more than one hour without recess.

At any time during the hearing, the Accused or the Judicial Board may move to terminate or to postpone the hearing or to qualify his plea or to modify its charge.

Pending verdict on charges (including appeal) against the Accused, his status as a student shall not be changed, nor his right to be on campus or to attend classes suspended, except that the Chancellor or Provost may impose an interim suspension upon any member of the University community who demonstrates, by his conduct, that his continued presence on the campus constitutes an immediate threat to the physical well-being or property of members of the University community or the property or orderly functioning of the University.

E. *Sanctions and the Verdict.* The Graduate School Judicial Board shall have the power to impose the following penalties: expulsion, dismissal from the University with the recommendation that the person never be readmitted; Suspension, dismissal from the University and from participation in all University activities for a specified period of time, after which the student may apply for readmission; Disciplinary Probation, placing the student on a probationary status for a specified period of time, during which conviction for violation of any regulation may result in more serious disciplinary action; Restitution, payment for all, or a portion of property damage caused during the commission of an offense. Restitution may be imposed by itself or in addition to any of the other penalties. The Judgment shall consist of a finding of guilty or not guilty of the charge and, when the Accused is found guilty, a statement of the punishment assessed. On all questions, including the verdict and the finding of guilty or not guilty, the Board shall be governed by a majority vote. The Judicial Board may decide to rehear a case in which significant new evidence can be introduced. In addition, the defendant may request an appeal.

F. *Appeals.* The appellant may submit to the Dean a written statement containing the grounds for his appeal and his arguments. In such cases, the Dean should determine if the appeal should be granted, and he can hear the case himself, or refer it to the appropriate faculty in the student's department or to the Judicial Board.

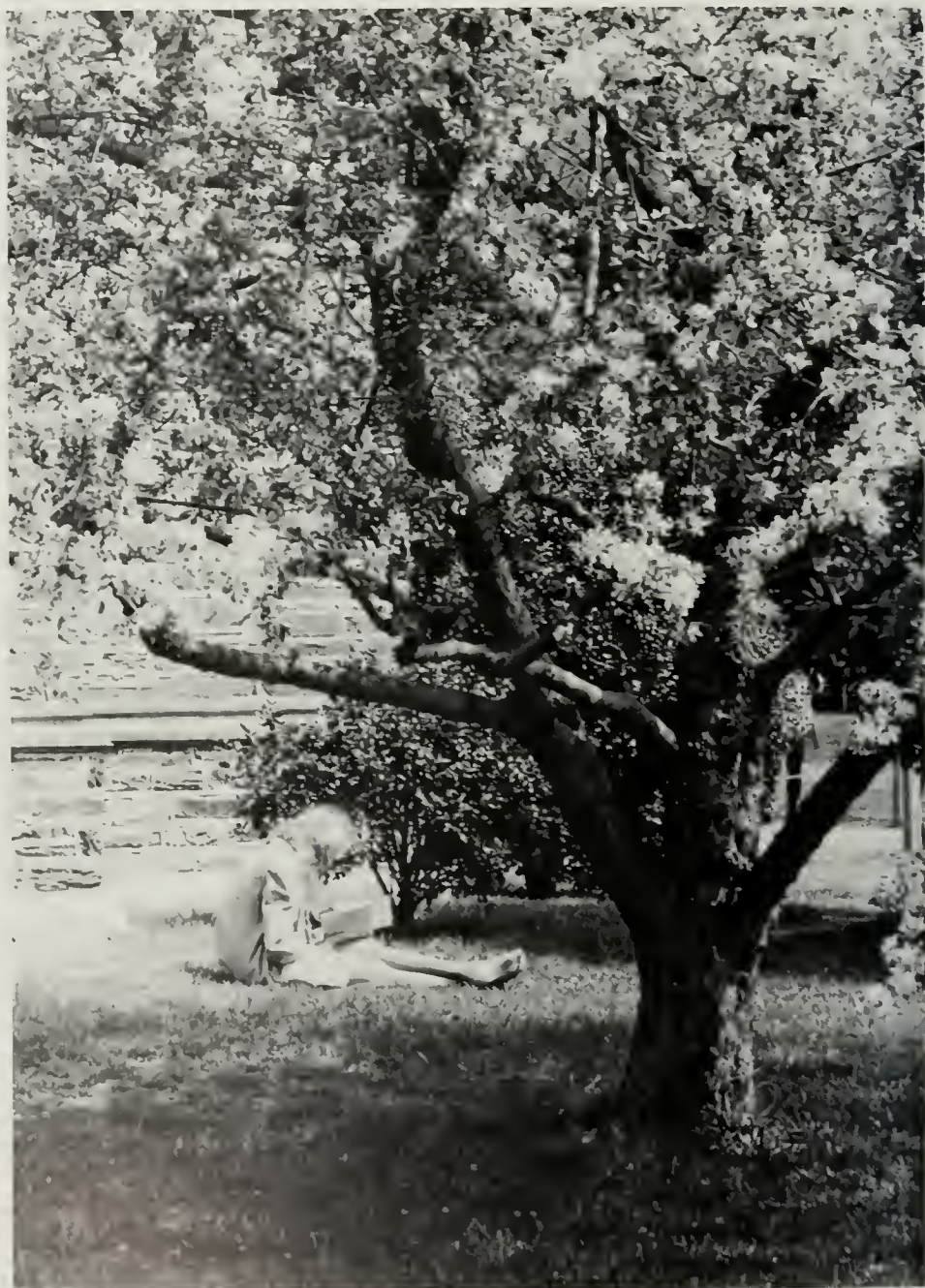
An appeal shall be granted on the following grounds: procedural error substantially affecting the rights of the accused; incompatibility of the verdict with the evidence; excessive penalty not in accord with "current community standards"; new evidence of a character directly to affect the judgment but on which the original tribunal had refused a new hearing.

### III. Amendment and Construction

This Judicial code and procedure and this constitution and procedure for the Graduate School Judicial Board may be amended at any time with due notice or publication by consent of the Dean, the Executive Committee, and the graduate students. Questions and problems not answered or anticipated by the foregoing may be resolved by the use of other existing institutions or by amendment.



# Study in the Summer







## Programs Offered

The 1977 Summer Session of Duke University will consist of three terms. The first term will begin on May 10 and will end on June 11; the second term will begin on June 13 and will end on July 15; and the third term will begin on July 18 and end on August 19. A graduate student who wishes to work toward an advanced degree in the summer session, particularly in chemistry, economics, education, English, history, mathematics, religion, sociology, and zoology, will find a selection of courses offered by members of the Duke faculty and by visiting professors. Other departments ordinarily offering work leading to the A.M. degree are botany, political science, and psychology. Thesis research for advanced graduate students is available also in most other departments, such as engineering, forestry, and physics.

A student wishing to be admitted to the Graduate School for work in the summer session should make application to the Dean of the Graduate School, as well as to the Director of Summer Programs, and should return the completed application, with supporting documents, before April 15 for admission to Term I; before May 15 for admission to Term II; and before June 15 for admission to Term III. (See the chapter on Admission.)

## Regulations Regarding Summer Work

No graduate student may register for more than 6 units of credit in one summer session term. All work required for the master's degree must be completed within six years of the date of matriculation. No residence credit can be accepted toward the requirement for the Ph.D. degree for work completed during the summer sessions. A student who completes, during the summer session, the work required by the University for an advanced degree will be granted the degree in September.

The *Bulletin of the Summer Session*, containing information about graduate courses, may be obtained by writing to the Director of Summer Programs, Duke University, Durham, North Carolina 27706.

# Courses of Instruction





## Course Enrollment

In general, courses with odd numbers are offered in the fall semester, those with even numbers in the spring semester. Double numbers separated by a hyphen indicate that the course is a year course and usually must be continued throughout the year if credit is to be received. A student must secure written consent from the instructor in order to receive credit for either semester of a year course. Double numbers separated by a comma indicate that although the course is a year course, credit may be received for either semester without special consent. Ordinarily, courses which bear no date are offered every year.

*Note:* In each department the number 399 is reserved to designate special (individual) readings in a specified area and supervised by a regular member of the graduate staff, with credit of one to three units each registration, only one course per registration, and nine units maximum in three successive registrations. The course is restricted to resident master's and doctoral programs, must have a completion exercise, and must carry a grade.

## Anatomy

Professor Robertson, *Chairman* (466 Sands); Associate Professor Hylander, *Director of Graduate Studies* (272 Sands); Professors Everett, Moses, and Peele; Associate Professors Cartmill, Counce, Duke, Erickson, Hall, Hylander, Longley, and Reedy; Assistant Professors Adelman, Blake, Corless, Fletcher, Johnson, Kay, Mahaley, Strickler, and Tyrey; Lecturer Diamond; Adjunct Assistant Professors Bergeron and Carpenter

The Department of Anatomy offers graduate programs designed to produce teachers and research workers competent in a broad range of anatomical sciences; A.M. and Ph.D. degrees are offered. Students with a wide variety of backgrounds and interests in the biological sciences can be accommodated. All students participate in a core of anatomical science courses (Anatomy 305, 307, 309) and gain experience in teaching over the range of departmental interests. Students are encouraged to round out their formal course work by drawing upon the offerings of other departments in the University, as well as those in the Anatomy Department. Laboratories within the department are equipped for and actively support research in

several areas. Some idea of the opportunities for degree research may be gleaned from the description of Anatomy 312. For further information contact the Director of Graduate Studies.

**207. Human Anatomy.** A lecture-laboratory-discussion course that examines human morphology and the fundamental relationships among the neurologic, musculo-skeletal, cardiovascular, gastrointestinal, respiratory, renal, and reproductive systems. The course includes cadaveric presentations of every major region of the human body. Intended primarily for students in allied health programs. Prerequisite: consent of instructor. Credit to be arranged; maximum 3 units. *Staff*

**208. Anatomy of the Trunk.** Designed for Ph.D. candidates in anatomy as well as general practitioners and specialists in surgery and internal medicine. Emphasis upon the anatomy of the thoracic, abdominal, and pelvic organs. Prerequisite: core course in anatomy. Enrollment: number of students to be arranged by staff. 2 units. *Duke*

**212. Cellular Endocrinology.** Relationships between the morphologic and functional characteristics of mammalian endocrine cells; drawing on light and electron microscopic, as well as physiological and biochemical investigations. Topics treated in the context of their relevance to endocrine systems include: physical basis of secretory processes, intercellular junctions and communication, immunocytochemical localization of hormones and receptors, topography of cell surfaces. Students are expected to become familiar with the pertinent literature and to present a brief seminar at the end of the course. Complementary to Anatomy 418. Prerequisites: Anatomy 307, or equivalent, and consent of instructor. Offered spring, 1978, and alternate years thereafter. Enrollment: minimum 5. 3 to 4 units. *Fletcher*

**215. Contractile Processes.** (Also listed as Physiology 216.) 3 units. *Anderson, Jöbsis, Johnson, or Reedy*

**216. Biological Psychology.** (Also listed as Psychology 216.) *Diamond*

**217. Structure and Function of Visual Photoreceptors.** A detailed study of available structural, biochemical, spectroscopic, and physiological data from retinal photoreceptors. Emphasis on molecular structure of vertebrate photoreceptor membranes, effects of bleaching on rhodopsin molecule, and initiation of neural information after photon absorption. Lectures, seminars, and demonstrations. Complements Anatomy 276. Offered fall, 1977, and alternate years thereafter. Prerequisites: Anatomy 276, 280, 286, 290, and 301; Zoology 246; physical chemistry; or consent of instructor. Credit to be arranged; maximum 4 units. *Corless*

**219. Molecular and Cellular Basis of Development.** A multidisciplinary approach stressing the molecular, cellular, and genetic processes involved in development and differentiation in prokaryotes and eukaryotes. Topics include: initiation of development, morphogenesis, developmental genetics, differentiation, and nuclear-cytoplasmic interactions in development. (Also listed as Biochemistry 219, Microbiology 219, Pathology 219, and Physiology 230.) 3 units. *Counce, Johnson, Kaufman, McCarty, and Padilla*

**219S. Seminar.** Optional seminar offered in conjunction with Anatomy 219. Students prepare and present seminar topics directly related to specific subjects discussed in Anatomy 219. Prerequisites: enrollment in Anatomy 219 and consent of instructor. 1 unit.

**231. Human Evolution.** Evolutionary biology of the primates. Anatomical and behavioral adaptations and phylogeny of fossil and living primates including



*Homo sapiens*. Prerequisite: Anthropology 93 or equivalent. (Also listed as Anthropology 231.) 3 units. *Cartmill*

**238. Functional and Evolutionary Morphology of Primates.** History and functional significance of locomotor and feeding adaptations, craniofacial morphology, sense organs, and reproductive systems in primates, including *Homo sapiens*. Prerequisite: Anatomy 231 (Anthropology 231), or equivalent, or consent of instructor. (Also listed as Anthropology 245.) 3 units. *Cartmill or Hylander*

**240. Mechanisms of Biological Motility.** Discussions, based on extensive readings, on the ultrastructure and biochemistry of biological motile systems. Introductory discussions of muscle contraction and sperm-cilia-flagella will form the basis for subsequent consideration of such weekly topics as amoeboid motion, fibroblast motility, protoplasmic streaming, mitosis, particle saltations, etc. Emphasis placed on defining similarities between systems with different phenomenologies of motion. Ends with a series of brief student seminars on topics from areas not covered in the principal seminars. Prerequisite: written consent of instructor. Enrollment: minimum 4; maximum 10. 3 units. *Adelman*

**246. The Primate Fossil Record.** (Also listed as Anthropology 246.) 3 units. *Kay*

**261. History of Generation and Mammalian Reproduction.** Theories of generation and of historical development of present-day concept of mammalian reproductive processes. Prerequisite: consent of instructor. Offered fall, 1977, and alternate years thereafter. (Alternates with Anatomy 263.) 1 unit. *Duke*

**263. History of Anatomy.** The lives and contributions of the founders of anatomy, Aristotle to the twentieth century. Prerequisite: consent of instructor. Offered fall, 1978, and alternate years thereafter. (Alternates with Anatomy 261.) 1 unit. *Duke*

**264. Mammalian Embryology and Developmental Anatomy.** Study of early embryology and organology of mammals, using the rat as the basic form and supplementing it with other mammalian forms, including primates. Prerequisites: one year of zoology and consent of instructor. 4 units. *Duke*

**265. Seminar in Chromosome Biology.** (Also listed as Zoology 265.) 2 units. *Moses and Nicklas (Zoology)*

**266. Seminar in Chromosome Biology.** See course description for Zoology 265. (Also listed as Zoology 266.) *Moses and Nicklas (Zoology)*

**276. Neuroanatomical Basis of Sensory Physiology.** Original papers read and discussed which are concerned with the neuroanatomical substrates underlying sensory processing in the auditory and visual systems. Prerequisite: consent of instructor. Offered spring, 1977, and alternate years thereafter. (Also listed as Psychology 276.) 3 units. *Hall*

**280. Structure and Assembly of Macromolecules.** Lectures and conferences on the structure of biological macromolecules and on the mechanisms of assembly of organized macromolecular aggregates such as are found in viruses and cellular organelles. Emphasis on the results of electron microscopic, X-ray diffraction, and optical analyses. Prerequisites: microscopic anatomy or cytology, or equivalent, and consent of instructor. Offered spring, 1977, and alternate years thereafter. (Alternates with Anatomy 286.) 3 units. *Longley, Corless, Erickson, Moses, Reedy, and Robertson*

**286. The Light Microscope, the Electron Microscope, and X-ray Diffraction in Biology.** Lectures and laboratories on methods of ultrastructure research. Fundamentals of optics; the light microscope, phase, polarizing, and interference micros-

copy. Basics of electron microscopy, staining, sectioning, and replication techniques. Optical and computer image processing. Introduction to X-ray diffraction theory and apparatus in structure determination. Prerequisites: microscopic anatomy or cytology, or equivalent; calculus; one year each of physics and general chemistry; consent of instructor. Offered spring, 1978, and alternate years thereafter. (Alternates with Anatomy 280.) 4 units. *Longley, Corless, Erickson, Moses, Reedy, and Robertson*

**288. Seminar on the Role of the Cell in Development and Heredity.** Topics of current interest and controversy. Prerequisites: a course in genetics and consent of instructor. Offered spring, 1977, and alternate years thereafter. (Also listed as Zoology 288 and under the University Program in Genetics.) 2 units. *Counce*

**291. Special Topics in Nerve Ultrastructure.** Each student chooses a topic, such as ultrastructure of synapses, or sensory nerve endings including the retina, or auditory nerve, or simple nerve nets, or morphological correlates of learning. Students pursue their topics in the library during the first half of the semester with guidance from the instructor in order to prepare a detailed paper. The second half of the semester is devoted to seminar presentations and discussions of the selected topics. Enrollment: minimum 5. 2 units. *Robertson*

**300. Gross Anatomy.** Gross anatomy for physical therapy students. Credit to be arranged; maximum 8 units. *Staff*

**303. Neuroanatomical Basis of Behavior.** Basic neuroanatomy and its physiological and functional correlates. 3 units. *Hall and Peele*

**305. Gross Human Anatomy.** Includes complete dissection of a cadaver; laboratory work is supplemented by conferences which place emphasis upon biological and evolutionary aspects. Prerequisites: adequate background in biology, including comparative anatomy and embryology; written consent of the Director of Graduate Studies. Required of entering graduate students in anatomy; by arrangement, may extend into second semester. 3 units. *Staff*

**307. Microscopic Anatomy.** Emphasis on the cell, its generalized structural and functional organization down to the molecular level, and differentiations of the cell in various organs and tissues. Introduction to light and electron microscopic and diffraction methods for investigating biological structure. Prerequisites: adequate background in biology, including comparative anatomy and embryology; written consent of the Director of Graduate Studies. Required of entering graduate students in anatomy; by arrangement, may extend into second semester. 3 units. *Staff*

**309. Neuroanatomy.** Gross and basic intrinsic anatomy of the central nervous system. Later, specific systems will be emphasized; various sensory and motor, limbic-hypothalamic, and cerebral-associated mechanisms. Clinical presentations will be offered. Prerequisites: adequate background in biology, including comparative anatomy and embryology; written consent of the Director of Graduate Studies. Required of entering graduate students in anatomy; by arrangement, may extend into second semester. 2 units. *Staff*

**312. Research.** Individual investigations in the various fields of anatomy. Laboratories in which a student may work include: three electron microscopy laboratories headed by Moses, Reedy, and Robertson with emphasis respectively on the fine structure and cell biology of chromosomes and associated structures, molecular structure and function of muscle, and biophysical studies of cell membranes and nervous tissue; physical anthropology laboratories and the Primate Facility under Bergeron, Cartmill, Hylander, and Kay concentrating on biomechanics, cyto-

genetics, comparative anatomy, and primate evolution and behavior; neuroanatomy laboratories under Peele, Hall, and Diamond emphasizing structural correlates of behavior and learning; cell biology and neuroendocrinology laboratories under Everett, Blake, and Fletcher with emphasis on brain mechanisms regulating reproductive functions of the pituitary gland and on intercellular communication in the pituitary and ovary; comparative anatomy laboratory under Duke focusing on ovarian structure and function; a functional vertebrate morphology laboratory under Strickler emphasizing morphology and behavior of bats; developmental biology laboratories under Counce and Johnson with emphasis on insect and amphibian morphogenesis and the role of cell membrane contact phenomena in differentiation; a cell biology laboratory under Adelman studying the biochemistry and phenomenology of primitive motility; and molecular structure laboratories under Longley, Erickson, and Corless using a combination of electron microscopy, X-ray diffraction, and optical and computer methods of image analysis to study respectively fibrous proteins, microtubules, and photoreceptor membranes. Prerequisite: consent of instructor. Credit to be arranged; maximum 6 units. *Staff*

**313, 314. Anatomy Seminar.** Regular meeting of graduate students and staff in which current research problems in anatomy will be presented. 1 unit each semester. *Staff*

**340. Tutorial in Advanced Anatomy.** Topics for intensive reading and discussion will be chosen according to the student's interests, related to basic problems in biophysics, cytology, endocrinological control, growth and development, neuroanatomy, physical differentiation, and evolutionary origins of functional microsystems. Prerequisite: consent of instructor. Enrollment: maximum 8. 3 units. *Staff*

**344. Advanced Neuroanatomy of Sensory and Motor Mechanisms.** The course will involve consideration of classic and modern concepts of somatic and special sensory systems and of somatic and visceral motor systems. Clinical correlations of basic neuroanatomy will be included. Enrollment: minimum 5; maximum 20. 3 units. *Peele*

**354. Research Techniques in Anatomy.** A preceptorial course in various research methods in anatomy. An interested student might engage in research in one of the following: anthropology, electron microscopy, X-ray diffraction, chromosome analysis, developmental biology, fetal physiology, primate behavior, primate anatomy, and stereotactic approaches to neuroendocrinology and neuroanatomy. Other topics may be arranged. Prerequisite: consent of instructor. Credit to be arranged. *Staff*

**418. Reproductive Biology.** See course description for Physiology 418. (Also listed as Physiology 418.) 2 units. *Anderson, Blake, Everett, Fletcher, Schomberg, and Tyre*

## Anthropology

Professor Friedl, *Chairman* (03 North); Professor Fox, *Director of Graduate Studies* (106 North); Professor LaBarre; Associate Professors Apte, Cartmill, Hylander, O'Barr, Rosen, and Smith; Assistant Professors Glander, Graedon (School of Nursing), Quinn, and Stack (Public Policy Sciences)

The department offers graduate work leading to the Ph.D degree in anthropology. Applicants for admission should submit scores on the Graduate Record Examination Aptitude Test.

Candidates for the Ph.D degree must demonstrate a general competence in



four major sub-fields (sociocultural anthropology, physical anthropology, anthropological linguistics, and prehistory) as well as specialization in one or more of these sub-fields. Recognizing a trend in modern anthropology toward interdisciplinary research, the department allows the student to replace some of the course work required for the Ph.D. degree by advanced work in anatomy, economics, psychology, sociology, zoology, or other disciplines relevant to a student's program.

Further details of the graduate program in anthropology, the departmental facilities, the staff, and various stipends available are described in the *Guidelines for Graduate Students in Anthropology* which may be obtained from the Director of Graduate Studies, Department of Anthropology.

### For Seniors and Graduates

**210. Linguistic Anthropology: Theory.** Examination and comparison of predominant schools of language study—comparative-historical, structural, transformational, stratificational, and generative semantics. Prerequisite: Anthropology 107 or consent of instructor. 3 units. *Apte*

**211. Linguistic Anthropology: Ethnography of Communication.** Verbal and nonverbal communication from linguistic and anthropological perspectives with emphasis on synchronic and diachronic aspects of communication, development of sociolinguistic theory and its application to intra- and inter-cultural communicative processes. Prerequisite: Anthropology 107 or consent of instructor. 3 units. *Apte*

**220S. Society and Culture in India.** The basic features of Indian cultures and societies from an anthropological perspective. The impact of selected technological and social changes upon the individual, caste, and community. Prerequisite: Anthropology 94 or 99, or consent of instructor. 3 units. *Apte or Fox*

**222. Topics in African Anthropology.** Research problems illustrated through ethnographic studies of African societies. 3 units. *O'Barr*

**242. Topics in Prehistory.** Anthropological issues derived from archeological and early historical investigations. Prerequisites: Anthropology 93 and 94, or equivalents. 3 units. *Staff*

**243. Theory and Method in Archeology.** Techniques of geochronology, environmental reconstruction, sociocultural reconstruction, and statistical analyses applied to problem areas in archeology—human cultural origins, Paleolithic and post-Pleistocene readaptations, origins of agriculture and civilization. Prerequisite: Anthropology 166 or consent of instructor. 3 units. *Staff*

**244. Primate Behavior.** Examination of the social behavior of prosimians, monkeys, and apes in an attempt to understand the evolutionary development of the order primate and the origin of man. 3 units. *Glander*

**245. Functional and Evolutionary Morphology of Primates.** History and functional significance of locomotor and feeding adaptations, craniofacial morphology, sense organs, and reproductive systems in primates, including *Homo sapiens*. Prerequisite: Anthropology 132 (Anatomy 231), or equivalent, or consent of instructor. (Also listed as Anatomy 238.) 3 units. *Cartmill or Hylander*

**246. The Primate Fossil Record.** Evolution of man and other primates as inferred from fossil remains. Prerequisite: a course in human evolution or consent of instructor. 3 units. *Cartmill or Kay*

**249. Topics in Economic Anthropology.** Prerequisite: Anthropology 94 or 99, or consent of instructor. 3 units. *O'Barr, Quinn, or Smith*



**250. The Anthropology of Cities.** Organization and behavior of men in urban centers analyzed from an evolutionary perspective; cross-cultural analysis of cities and their varying roles. Prerequisite: Anthropology 94 or 99, or consent of instructor. 3 units. *Fox*

**251. Ethnography of Humor.** Examination of theoretical framework, research methods and data-collection techniques for the analysis of humor with the goal of discerning normative behavioral patterns, expectations regarding social roles, interpersonal relationships and social institutions, and the nature of ideologies and world views, within and across cultures. Prerequisite: Anthropology 94 or 99, or consent of instructor. 3 units. *Apte*

**259. Linguistic Anthropology: Language Acquisition.** Biological basis of human linguistic capacity; major theoretical positions in linguistics; acquisition of semantics, syntax, and phonology in English and other languages. Prerequisite: Anthropology 107 or consent of instructor. 3 units. *Staff*

**264. Primitive Religion.** The ethnology, social functions, and the socio-psychological meanings of religion in primitive societies. 3 units. *Staff*

**265. Personality and Society.** The sociology and social psychology of human personality, its origins in the primary group, its nature and varieties, and its integrations into secondary group institutions. 3 units. *Staff*

**266. Personality and Culture.** The influence of culture patterns and social institutions upon character structure, socialization of the individual, and the dynamics of human personality. Comprehensive anthropological materials will be drawn upon. 3 units. *Staff*

**267. Cognitive Anthropology.** Theoretical and methodological developments in the study of taxonomies, naturally occurring categories, information-processing rules, decisions, and belief systems. Psychological testing of non-Western people; effects of schooling. Prerequisite: Anthropology 94 or 99. 3 units. *Quinn*

**268. Law and the American Indian.** Survey of the legal status and problems of the contemporary American Indian. Topics include the basis and extent of tribal sovereignty, the relation of states and their Indian citizens, treaties and Indian claims actions, the legal context of economic development, and the legal position of Eastern American Indians. 3 units. *Rosen*

**269. Topics in Law and the Social Sciences.** Examination of the relation between law and the social sciences. Topics will be chosen from among the following: the use of social science data by American courts, the legal and social basis of property holding, the development of legal institutions in the new nations, experimentation with human subjects, and domestic relations and the American legal system. 3 units. *Rosen*

**270. Ethnographic Field Methods.** Research strategies and techniques for field research; participation in a field project in a local community. 3 units. *O'Barr or Quinn*

**271. Methods of Data Analysis.** Quantitative analysis of anthropological data. 3 units. *Quinn*

**272. Primitive Music.** A comparative ethnological study of non-Western music, emphasizing different scales (mode, raga, magam, lu), conventions, styles, social functions, and cultural contexts; some attention to the African origins of jazz. Sufficient technical background will be provided for the nonspecialists. 3 units. *Staff*

**273. Primitive Art.** A comparative ethnological study of non-European art and artists emphasizing media, conventions, social functions, and cultural contexts. 3 units. *Staff*

**275. Rank, Power, and Authority in Pre-Industrial Societies.** The role and development of social, economic, and political stratification in specific societies in Oceania, Africa, and the New World. Prerequisite: major in anthropology or graduate standing. 3 units. *Fox*

**276. Analysis of Kinship Systems.** Primitive relationship categories as related to legal norms and social groupings. Theoretical issues and contrasting approaches to the analysis of social classification terminologies. 3 units. *Staff*

**277. Class, Ethnicity, and Public Policy.** (Also listed as Public Policy Sciences 275.) 3 units. *Stack*

**278S. Special Topics in Political Anthropology.** Current research problems. Topics will change each semester. Prerequisite: Anthropology 134 or consent of instructor. 3 units. *O'Barr or Quinn*

**280S, 281S. Seminar in Selected Topics.** Special topics in methodology, theory, or area. Prerequisite: consent of instructor. 6 units. *Staff*

**291, 292. Anthropological Theory.** Theoretical, methodological, and comparative issues. Prerequisite: consent of instructor. 6 units. *Fox or Quinn*

## For Graduates

**330, 331. Seminar in Anthropology.** A seminar for advanced students who wish to pursue individual studies in social and cultural anthropology. Offered both semesters. 1 to 3 units each semester. *Staff*

**334. Topics in Physical Anthropology.** See course description for Anatomy 334. (Also listed as Anatomy 334.) 3 units. *Staff*

**335, 336. Linguistic Theory and Methods.** Basic course for graduate students in the anthropology graduate program. 3 units. *Apte*

**393. Individual Research in Anthropology.** A course for the student preparing the A.M. thesis or the Ph.D. dissertation. Supervision and guidance of intensive research on a problem approved by the student's departmental advisory committee. 3 units. *Staff*

**402. Interdisciplinary Seminar in the History of the Social Sciences.** A survey of the theories, methods, and tools applied to problems in the history of the social sciences. 3 units. *Goodwin, Holley, and Spragens*

**410. Seminar in the Government, History, and Social Structure of India and Pakistan.** 3 units. *Fox and Staff*

## Art

Professor Markman, *Director of Graduate Studies*; Professors Jenkins, Mueller, and Sunderland; Assistant Professors Brown, Connolly, and Lichtenstein

Graduate work in the Department of Art is offered leading to the A.M. degree in art history and is designed to provide basic training in the history of art with specialization in a given field selected by the student after consultation with and approval of the Director of Graduate Studies. Prospective students should present a minimum of 24 semester hours of undergraduate work in the history of art. In

special cases a student who does not fulfill this prerequisite may be required to attend prescribed undergraduate courses. A reading knowledge of one foreign language (preferably German) is required; candidates who do not meet this requirement upon admission to the program are expected to do so by the end of their first term in residence.

The program for the A.M. degree in art history consists of 30 units as follows: 12 units in art history; 6 units in an approved minor; 6 units in the major or minor, or other approved subject; and 6 units in thesis. A written thesis is required. Candidates must also pass written comprehensive examinations testing their knowledge of art history and pertinent bibliographical resources.

### For Seniors and Graduates

**233. Early Medieval Architecture.** The development of religious architecture from the time of Constantine to the end of the First Romanesque style in the third quarter of the eleventh century. 3 units. *Sunderland*

**237. French Renaissance Art.** Sixteenth-century painting and sculpture in France with special emphasis on Italian influences. Prerequisites: some knowledge of Italian Renaissance art and the ability to read French, or consent of the instructor. 3 units. *Jenkins*

**244. Neoclassicism.** Origin and evolution of Neoclassicism in the visual arts emphasizing comparison to contemporary stylistic alternatives and international aspects of the style. Prerequisite: Art 66 or consent of instructor. 3 units. *Connolly*

**247. Problems in the History of Graphic Arts.** Selected topics in the history of prints and drawings. 3 units. *Mueller*

**249. Problems in Pre-Columbian Art and Archeology.** Architecture, sculpture, and other arts of the indigenous civilizations in Mexico, Central America, and the Andean region. Prerequisite: consent of instructor. 3 units. *Markman*

**250. Problems in Latin American Art.** Architecture, painting, sculpture, and other arts with emphasis on colonial architecture of Central America. Open to seniors who have a reading knowledge of Spanish and/or have had courses in Latin American history, economics, or literature. 3 units. *Markman*

**254. Problems in Modern Architecture.** A particular movement, master, or idea studied as a problem in criticism and methodology; influence on design and building. Prerequisite: Art 61 or consent of instructor. 3 units. *Brown*

**257, 258. Problems in Modern Art.** Selected topics in nineteenth and twentieth-century European art, with emphasis on one or more major movements or masters. Prerequisite: Art 66 or 148, or consent of instructor. 6 units. *Lichtenstein*

**259. Romanticism.** Emphasis on the French school of painting; sources in English, German, and Spanish art. Prerequisites: knowledge of nineteenth-century art and ability to read French, or consent of instructor. 3 units. *Lichtenstein*

**293, 294. Special Problems in Art History.** Individual study and research. 6 units. *Staff*

### Asian Languages

The course is offered as an enrichment for students interested in the South Asian subcontinent and may be taken as a general elective by advanced undergraduate students. No major work is offered in Hindi-Urdu.

**Hindi-Urdu 200-201. Special Studies in South Asian Languages.** Intensive concentration in advanced Hindi reading and conversation, or specialized graded work in cognate South Asian languages necessary for the advanced student contemplating field work in South Asia. Prerequisite: consent of instructor. 6 units. *Staff*

**Hindi-Urdu 203. Studies in Commonwealth Literature.** Readings in English. Study of the literature of the Commonwealth countries of South Asia, Africa, South East Asia, Australia, New Zealand and the British West Indies. Emphasis on contemporary fiction in particular, and all creative writing in general, to social, political, and economic change in the post-colonial period. 3 units. *Shonek*

For courses in Chinese and Japanese, see *Bulletin of Undergraduate Instruction*.

## Biochemistry

Professor Hill, *Chairman* (255 Nanaline H. Duke); Professor Gross, *Director of the Genetics Division* (151 Nanaline H. Duke); Professor Rajagopalan, *Director of Graduate Studies* (235B Nanaline H. Duke); Professors Fridovich, Guild, Handler,\* Harris, Kamin, Kirshner, McCarty, Tanford, and Webster; Associate Professors Appel, Greene, Kaufman, Kim, Lynn, Reynolds, Richardson, Sage, Siegel, and Sullivan; Assistant Professors Bell, Habig, Hall, Holmes, Kredick, Lefkowitz, McKee, and Wheat; Associates Bittikofer, Nozaki; Assistant Medical Research Professors Bonaventura, McCord, and Steinman

Graduate work in the Department of Biochemistry is offered leading to the Ph.D. degree. Preparation for such graduate study may take diverse forms. Undergraduate majors in chemistry, biology, mathematics, or physics are welcome, but adequate preparation in chemistry is essential. Graduate specialization areas include protein structure and function, crystallography of macromolecules, nucleic acid structure and function, lipid biochemistry, membrane structure and function, molecular genetics, enzyme chemistry, and neurochemistry. The Division of Genetics of the department, in cooperation with the University Program in Genetics, offers biochemistry students the opportunity to pursue advanced research and study to fulfill the requirements for the Ph.D. degree.

**204. Introductory Genetics.** An introduction to genetic analysis with emphasis on the molecular basis of mutation, segregation, function, and organization of the genetic material. Primarily for medical students, but graduate students may be admitted with the instructor's consent. (Also listed under the University Program in Genetics.) 3 units. *Gross and Others of the University Program in Genetics*

**209-210. Independent Study.** A tutorial designed for students who are interested in either a laboratory or a library project in biochemistry. Credit to be arranged. *Staff*

**216. Molecular Genetics.** Genetic mechanisms and their relationship to nucleic acids and their synthesis. Prerequisites: introductory courses in biochemistry and genetics, or consent of instructor. (Also listed under the University Program in Genetics.) 4 units. *Guild and Others of the University Program in Genetics*

**219. Molecular and Cellular Basis of Development.** See course description for Anatomy 219. (Also listed as Anatomy 219, Microbiology 219, Pathology 219, and Physiology 230.)

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\*On leave of absence.



**219L.** Optional laboratory offered in conjunction with the lecture. Techniques of organ and cell culture, chromosome morphology, and some electron microscopy as applied to development and differentiation. 2 units. *Bolognesi, Harris, Johnson, Kaufman, and McCarty*

**219S. Seminar.** Optional seminar in conjunction with Biochemistry 219.

**220. Adaptations of Organisms to the Marine Environment.** Basic concepts of biochemistry and variables in the marine environment which evoke adaptive responses. Adaptations at the molecular level and the general topic of biological fitness are considered. Laboratory experiments utilize basic methods of biochemical analysis. Prerequisites: basic biology and chemistry, and consent of instructor. 1 unit. *Bonaventura*

**222. Structure of Biological Macromolecules.** Introduction to the techniques of structure determination by X-ray crystallography and study of some biological macromolecules whose three-dimensional structures have been determined at high resolution. 2 units. *Kim and Richardson*

**224. Biochemistry of Development and Differentiation.** The course represents an extension of topics covered in the first semester course 219. Emphasis will be on the control of transcription and translation of messenger RNA in mammalian cells. These studies include gene amplification, postsynthetic modifications of chromosomal proteins, as a result of hormone induction. Specific systems will include the development of the mammary gland, the pancreas, and the chick oviduct. 1 unit. *McCarty*

**241. General Biochemistry.** An introductory survey of fundamental aspects of biochemistry with emphasis on the structure of macromolecules, mechanism of enzyme action, metabolic pathways, biochemical genetics, and the structure and functions of special tissues. Designed for medical students; graduate students only with consent of instructor. 4 units. *Hill and Staff*

**248. Introductory Biochemistry.** The chemistry of proteins, lipids, carbohydrates, and nucleic acids and the metabolic interrelationships of these compounds. Prerequisite: organic chemistry. (Also listed as Botany 248 and Zoology 248.) 3 units. *Kim and Staff*

**276. Comparative and Evolutionary Biochemistry.** Lectures and discussion of the origin of life, evolution of genetic code, mutation and protein polymorphism, natural selection and protein structure, and comparison of homologous proteins and nucleic acids. Laboratory work involves the purification and characterization of homologous proteins from fish and invertebrates. Techniques include salt fractionation, electrophoresis, ion-exchange and molecular exclusion chromatography, fingerprinting, molecular weight determination, amino acid composition, and other related approaches. Prerequisite: consent of instructor. Given at Beaufort. 6 units. *Sullivan*

**282. Experimental Genetics.** Laboratory exercises and discussions on the molecular mechanisms of mutation, recombination, replication, transcription, and translation of the genetic material. Prerequisite: consent of instructor. (Also listed under the University Program in Genetics.) 2 units. *Hall and Others in the University Program in Genetics*

**284. Current Topics in Genetic Mechanisms.** A seminar and lecture course devoted to the analysis of the current literature in molecular genetics. Given in response to adequate demand. Prerequisites: Genetics 280, or equivalent, and consent of instructor. (Also listed under the University Program in Genetics.) 1 unit. *Hall and Others of the University Program in Genetics*

**286. Current Topics in Immunochemistry.** The structure, function, and specificity of antibodies. Immunogenicity and tolerance with special emphasis on current theories of the diversity and synthesis of antibody molecules. 2 units. *Sage*

**288. The Carbohydrates and Lipids of Biological Systems.** The subjects will be considered in the following two general categories: (a) the relationship between chemical structure and biological function, and (b) biosynthesis and catabolism. 2 units. *Kaufman*

**290. Bioenergetics.** Biological mechanisms of transduction of energy (covalent, ionic, photonic, and electric) will be considered, using photosynthetic, oxidative, phosphorylative, and glycolytic systems as examples. Since many of the above processes occur in membranous systems, the role and function of membranes in these processes will also be considered. 2 units. *Lynn*

**291. Physical Biochemistry.** Principles of thermodynamics, hydrodynamics, spectroscopy, and X-ray diffraction and scattering are applied to biological systems. Biological molecules and macromolecules in both soluble and crystalline states are discussed. Prerequisite: undergraduate physical chemistry, including solution thermodynamics, kinetics, introductory quantum mechanics, and introductory crystallography. 3 units. *Tanford, Reynolds, Richardson, and Kim*

**292. Proteins and Enzymes.** Topics in protein chemistry including purification techniques, determination of primary structure, group specific modification and structure-function correlations. Mechanisms of action of enzymes, including the chemistry of non-protein cofactors. Prerequisite: advanced organic chemistry. 4 units. *Fridovich, Rajagopalan, Hill, and Steinman*

**296. Biological Oxidations.** A lecture, conference, and seminar course on the mechanism of electron transport and energy conservation in purified enzymes and in organized systems such as the mitochondrion, the endoplasmic reticulum, and the chloroplast. 2 units. *Fridovich, Kamin, Rajagopalan, and Siegel*

**297. Intermediary Metabolism.** The synthesis and degradation of carbohydrates, lipids, proteins, and nucleic acids will be discussed in detail with emphasis on energy transformation and metabolic interrelationships. 3 units. *Bell, Greene, Kirshner, and Siegel*

**299. Nutrition.** This course examines the experimental basis for the identification and quantification of requirements for calories, macronutrients, and micronutrients—vitamins and minerals; the biochemistry of nutrition with the assessment of nutriture; and the biological effects of deficiency or excess of nutrients. The course seeks to define optimal nutriture and will search for factual bases for common beliefs on nutrition. Informal lectures and, if possible, student seminars. Prerequisite: a basic biochemistry course, or equivalent, or consent of instructor. 2 units. *Kamin*

**302. Neurochemistry.** Aspects of structure, function, and metabolism unique to the nervous system. Properties and interactions of neuroreceptors and nerve-muscle relationships. 3 units. *Appel, Bell, Kaufman, Kirshner, and Vanaman*

**345, 346. Biochemistry Seminar.** Required of all biochemistry students. 1 unit each semester. *Bell*

**351, 352. Genetics Seminar.** Required of all students specializing in genetics. (Also listed under the University Program in Genetics.) 1 unit each semester. *Hall and Others of the University Program in Genetics*

**390. Biochemistry of Membranes.** Physical and chemical properties of biological membranes. Properties of constituent lipids and proteins in relation to mem-

brane function. Prerequisite: Biochemistry 293 or equivalent. 2 units. *Bell, Reynolds, and Tanford*

## Botany

Professor Wilbur, *Chairman* (149 Biological Sciences); Associate Professor Searles, *Director of Graduate Studies* (257 Biological Sciences); Professors Anderson, Billings, W. Culberson, Hellmers, Johnson, Naylor, Philpott, Stone, and White; Associate Professors Antonovics, Barber, Boynton, Knoerr, and Strain; Assistant Professors Christensen and Siedow; Lecturer C. Culberson

Graduate work in the Department of Botany is offered leading to the A.M. (nonthesis), M.S. (thesis), and Ph.D. degrees. Before undertaking graduate study in botany a student should have had in the undergraduate program at least 12 semester hours of botany beyond an elementary course, and related work in biological sciences. Some work in chemistry and physics will be desirable and, for some phases of botanical study, a necessity. The student's graduate program is planned to provide a broad basic training in the various fields of botany, plus intensive specialization in the field of the research problem.

**203. Cytogenetics.** Organization and variation of chromosomes in relation to genetics and evolution. Meiotic behavior and variations, chromosomal rearrangements, polyploidy, karyotype evolution, and mechanisms of chromosomal changes. Prerequisite: one year of biology. 3 units. *Anderson*

**203L. Cytogenetics.** See Botany 203. Lectures and laboratories. 4 units. *Anderson*

**204L. Marine Microbiology.** The major groups of marine microorganisms, their taxonomy, culture, physiology, and ecology. Prerequisite: a course in introductory biology or botany. Given at Beaufort. 6 units. *Staff*

**206L. Anatomy of Woody Plants.** Primary and secondary structures in seedlings and in mature trees, shrubs, and vines. Preparation techniques for gross observations, and for study of micro and ultrastructures with light and electron microscopy. Relationship of microstructures to growth habits and physical properties of woody plant parts. Comparative studies in relation to ecological and systematic topics. (Also listed as Forestry 206.) Prerequisite: college botany or biology. 4 units. *Philpott*

**207L. Microclimatology.** (Also listed as Forestry 207.) 3 units. *Knoerr*

**209L. Lichenology.** Morphology, systematics, and biological and ecological implications of the lichens. Collection and identification of specimens and the use of lichen chemistry in taxonomy. 3 units. *W. Culberson* or *C. Culberson*

**210L. Bryology.** Morphological, systematic, and ecological characteristics of mosses and liverworts. 3 units. *Anderson*

**211L. Marine Phycology.** An introduction to marine algae; their identification, taxonomy, morphology, physiology, and ecology. Field trips complemented by laboratory study, culturing, and preparation of herbarium material. Given at Beaufort. 6 units. *Searles*

**212L. Phycology.** Morphological and ecological characteristics of common freshwater and marine algae and principles of their classification. 4 units. *Searles*

**214L. Biological Oceanography.** See Zoology 214. Given at Beaufort. 6 units. *Barber*

**217L. Environmental Instrumentation.** (Also listed as Forestry 217.) Prerequisite: consent of instructor. 3 units. *Knoerr*

**221L. Mycology.** Field and laboratory study of vegetative and reproductive structures of the fungi and slime molds. Methods of collection, isolation, propagation, and identification of the major orders as represented in local flora. Prerequisite: one year of biological science. 4 units. *Johnson*

**225T, 226T. Special Problems.** Students with adequate training may do special work in the following fields. Credit to be arranged. 1 to 4 units.

1. Cytology; Bryology. *Anderson*
2. Genetics. *Antonovics*
3. Ecology. *Billings*
5. Genetics *Boynton*
6. Ecology. *Christensen*
7. Lichenology. *Culberson*
8. Physiology. *Hellmers*
9. Bacteriology; Mycology. *Johnson*
10. Physiology. *Naylor*
11. Anatomy and Morphology of Vascular Plants. *Philpott*
12. Phycology. *Searles*
13. Systematics of Flowering Plants. *Stone*
14. Ecology. *Strain*
15. Anatomy and Morphology of Vascular Plants. *White*
16. Systematics and Taxonomy of Vascular Plants. *Wilbur*
17. Physiology. *Siedow*

**233L. Microbiology.** Introduction to bacteriology, virology, cell biology, and immunology. Structure, metabolism, and growth of bacteria; the properties of bacterial and animal viruses; and basic immunology. (Also listed as Microbiology 233.) 3 units. *Amos (Microbiology), Burns (Microbiology), Joklik (Microbiology), or Willett (Microbiology)*

**235. Evolutionary Systematics.** See Zoology 235. 3 units. *Bailey (Zoology), Lundberg (Zoology), and Stone*

**235L. Evolutionary Systematics.** Same course as 235 with laboratory included. 4 units. *Bailey (Zoology), Lundberg (Zoology), and Stone*

**236S. Major Global Ecosystems.** Study of a single global ecosystem such as arctic-alpine, desert, tropical rainforest, grassland, or coniferous forest, including the place and effects of both primitive and modern man. 3 units. *Billings*

**242L. Systematics.** Principles of vascular plant taxonomy, with practice in collection and identification of local flora. Lectures, laboratories, and field trips. Prerequisite: one year of biology. 4 units. *Wilbur*

**245L. Plant Diversity.** Major groups of the living plants, their evolutionary origins and phylogenetic relationships. Prerequisite: introductory biology. 4 units. *W. Culberson and White*

**246L. Ecology of Plants.** Principles of the relationships between plants and their environments. Structures and processes of ecosystems. Laboratory, lectures, and field trips. Prerequisites: introductory biology and one other course in biology. 4 units. *Billings, Christensen, or Strain*

**248. Introductory Biochemistry.** The chemistry of proteins, lipids, carbohydrates, and nucleic acids; metabolic interrelationships of these compounds. Prerequisites: Chemistry 151, one year of college physics (second semester may be taken concurrently), and Mathematics 32. (Also listed as Biochemistry 248.) 3 units. *Staff*



**250L. S. Plant Biosystematics.** Descriptive and experimental procedures used to assess systematic implications of vascular plant evolution. Laboratory, discussion, and field oriented problems. Prerequisites: basic courses in systematics and genetics. 4 units. *Stone*

**251L. Plant Physiology.** The principal physiological processes of plants including respiration, photosynthesis, water relations, and factors associated with plant morphogenesis. Prerequisites: introductory college biology and one year of chemistry; organic chemistry is desirable. 4 units. *Siedow*

**253. Advanced Plant Physiology.** Physiological consequences of physical principles as related in ion transport, water relations, and the interconversion of energy in plant cells. Prerequisites: Botany 151L; Mathematics 32 or equivalent. 3 units. *Naylor and Siedow*

**256. Physiological Role of Minerals and Water.** Availability, uptake, transport, and function of minerals and water in plant growth. Prerequisite: Botany 151L or equivalent. 3 units. *Hellmers*

**257S. Principles of Plant Distribution.** Interpretation of floristic and ecological plant geography. Prerequisite: Botany 146L or equivalent. 3 units. *Billings*

**258. Physiology of Growth and Development.** Consideration of the internal factors and processes leading to the production of new protoplasm and its differentiation at the cellular, tissue, and organ level in plants. Lectures. Prerequisite: Botany 151L or equivalent; organic chemistry is recommended. 3 units. *Naylor*

**260L. Plant Anatomy.** A comparative study of basic cell types, tissues, and organs of vascular plants. Correlation of anatomical information with pertinent literature, application of anatomy to problems in systematics and evolution, and the interrelationship between structure and function. Prerequisite: one year of biology or consent of instructor. 4 units. *White*

**261. Photosynthesis.** Principles of plant photosynthesis: developmental, mechanistic, regulatory, and ecological aspects of the photosynthetic process. Prerequisite: Botany 151L or 251L. *Naylor and Siedow*

**265L. Physiological Plant Ecology.** The physiological approach to interpreting adaptation in plants, with emphasis on terrestrial seed plants. Prerequisites: Botany 146L and 151L, or equivalents. 3 units. *Strain*

**267L. Plant Community Ecology.** Concepts and methods of plant synecology. Introduction to the plant communities of North Carolina. Prerequisites: Botany 142L and 146L, or equivalents, and consent of instructor. 3 units. *Christensen*

**280. Principles of Genetics.** Structure and properties of genes and chromosomes, and evolution of genetic systems. Prerequisites: introductory courses in biology, chemistry, and mathematics, or equivalents. (Also listed as Botany 180, Zoology 180, and Zoology 280.) 3 units. *Antonovics, Boynton, and Gillham (Zoology)*

**280L. Principles of Genetics.** Same course as 280 with laboratory included. 3 units. *Antonovics, Boynton, and Gillham (Zoology)*

**285S. Population Genetics.** A seminar and lecture course devoted to the analysis of the current literature in population genetics. Prerequisites: genetics or Botany 280, or equivalent, and consent of instructor. (Also listed as Genetics 285.) 3 units. *Antonovics*

**286. Evolutionary Mechanisms.** See course description for Zoology 286. (Also listed as Zoology 286 and under The University Program in Genetics.) 3 units. *Antonovics and H. Wilbur (Zoology)*

**287S. Quantitative Genetics.** Analysis of genetic variation in continuous traits. Models of continuous variation; genetic, environmental, and interaction components; genetic correlation; heritability estimation; selection response. Prerequisites: Botany 180 or 280, or equivalent, and consent of instructor. 3 units. *Antonovics*

**295S, 296S. Seminar.** Credit to be arranged. *Staff*

**300. Tropical Biology: An Ecological Approach.** Highly intensive, field-oriented course conducted in Costa Rica under auspices of the Organization for Tropical Studies. For additional information refer to Special and Cooperative Programs in this *Bulletin*. 6 to 8 units. *Staff*

**305. Tropical Studies.** Highly intensive, field-oriented courses conducted in Latin America under auspices of the Organization for Tropical Studies. For additional information refer to Special and Cooperative Programs in this *Bulletin*. 4 to 8 units. *Staff*

**344S. Advanced Topics in Micrometeorology and Biometeorology.** See course description for Forestry 344. (Also listed as Forestry 344.) 2 units. *Knoerr*

**359-360. Research in Botany.** Individual investigation in the various fields of botany. Credit to be arranged. *All Members of the Graduate Staff*

**The University Program in Genetics.** Genetics courses offered by the Botany Department are an integral part of this interdepartmental program. Refer to the announcement in this *Bulletin* under the University Program in Genetics for description of the offerings.

204, Introductory Genetics; 215, Bacteriophage: Structure and Function; 216, Molecular Genetics; 236, Human Genetics; 280, Principles of Genetics; 282, Experimental Genetics; 284, Current Topics in Genetic Mechanisms; 285, Population Genetics; 287S, Quantitative Genetics; 336, Immunogenetics; 351-352, Genetics Seminar.

**Program in Tropical Biology.** Fellowships are available for travel and subsistence in field-oriented programs in Central America. Refer to the section Organization for Tropical Studies in this *Bulletin* in the chapter on Special and Cooperative Programs.

**The University Program in Marine Sciences.** Interdisciplinary programs emphasizing marine botany are available. Refer to the section in this *Bulletin* entitled Marine Sciences—The University Program.

## Business Administration

Thomas F. Keller, Ph.D., *Dean* (115 Social Science); Professors Baligh, Cohen, Keller, Laughhunn, Lewin, Peterson; Associate Professors Abdel-khalik, Baker, Battle, Burton, Dellinger, Hughes, and Morse; Assistant Professors Aldrich, Damon, Eaker, Espejo, Kessler, Kuhn, Magat, Maier, Scheiner, Taylor, Vander Weide, Westbrook, and Zalkind

The Graduate School of Business Administration offers work leading to the M.B.A., M.M., and Ph.D. The programs of study leading to the first two degrees are described in the *Bulletin of the Graduate School of Business Administration*. The Ph.D. program is designed for students who desire to enter either the academic profession or advanced and specialized administrative research positions. The program accepts students with bachelor's degree preparation and normally requires three to four years.

One year of study (30 units) beyond completion of the Duke M.B.A. degree or its equivalent is planned for each doctoral candidate. The year of study should in-

clude two courses in advanced economic theory, two courses in mathematics or statistics, and three courses in an elected field of administration. The latter are individually designed and are offered on a tutorial basis to provide extensive reading in the historical and current literature, and a demanding research program.

The requirements of the Graduate School are applicable to students in the Ph.D. program in business administration.

Management Science courses open only to students in Health Administration are listed under the Department of Health Administration.

**301. Managerial Economics II.** Focuses on developing an understanding of the economic environment of the organization with emphasis on the determinance of price level, rate of growth, interest rates, and the level of aggregate income, employment, and output in the economy. Examination of such current economic issues as inflation, international economic relations, and unemployment. **3 units.**

**309.1-.9. Research in Managerial Economics.** 1 to 6 units.

**312. Operations Research.** The development and study of quantitative models useful for structuring and solving strategy problems of the firm, and used in the third and fourth semester strategy courses. Emphasis on structuring problems in terms of quantitative models, generating solutions using both analytical and simulation approaches with and without computers, performing sensitivity analysis, implementing solutions, and developing a perspective about the role of quantitative models in management decision processes. **3 units.**

**313. Advanced Operations Research.** Problems of organization for an operations research project, formulation of the problem, model construction, interpretation of analytical results, and implementation. Selected cases of particular applications of operations research from the literature. Methodologically, some attention is devoted to advanced solution techniques as necessary to complete student projects, but primary attention is focused on formulation and use of models, the modification of existing models, or the development of new ones. **3 units.**

**319.1-.9. Research in Quantitative Methods.** 1 to 6 units.

**320-321. Organization Theory and Management I, II.** Provides the first year M.B.A. degree student with an understanding of macroscopic (corporate level) and microscopic (small-group and individual level) organizational phenomena. At the macroscopic level, these courses are concerned with the study of organizations as socioeconomic-political systems for collective action imbedded in an uncontrollable environment. At the microscopic level, these courses examine the social and psychological foundations necessary to understand the behavior and dynamics of individuals and small groups within organized settings as well as the administrative strategies available to the firm for influencing and modifying such behavior. **3 units each semester.**

**329.1-.9. Research in Organization Theory and Management.** 1 to 6 units.

**333. Controllership.** Develops systems for collecting and summarizing data in a manner which meets the requirements of the management team in controlling and planning operations. The function of the controller, as the center of synthesis and analysis of data, is studied in the context of the foundations established during the first three semesters. **3 units.**

**334. External Reporting and Auditing.** Builds on the information systems sequence of the first year and the public policy course, in terms of developing requirements of the system for reporting to parties external to the firm who have need for information about the activities of the enterprise for decision-making pur-



poses. Communication and measurement problems as well as the role of the independent auditor in developing evidence of and attesting to the reliability of data are studied in detail. 3 units.

**335. Management Information and Control Systems.** Problems associated with the design and operation of the information systems necessary to support strategic planning of an organization and to support the organization's control system. The role of information in planning and control, the economics of information, the dynamics of information flows, technologies of information systems, information system design, data base construction and maintenance, and reporting systems. 3 units.

**339.1-.9. Research in Information and Accounting Systems.** 1 to 6 units.

**345. Legal Environment of the Firm.** Emphasis on the legal system, the process by which laws are formulated and changed, and the type and forms of legal constraints imposed on firms. Also examined are major legislation, court cases, and regulation by federal agencies which affect the firm's decisions. 2 units.

**346. Public Policy of the Firm.** Builds on the theory of market failure to describe the rationale for societal intervention in business activities and reasonable firm responses. Topics include environmental action, monopoly relations, discrimination, poverty, consumer issues, and problems arising from shifts in demand and supply. 3 units.

**349.1-.9. Research in Public Policy and Social Responsibility.** 1 to 6 units.

**355. Financial Strategy.** Strategic problems associated with the acquisition of financial resources from the external market and their effective utilization and control within the organization. Capital markets, evaluation of the firm, short-run resource planning (cash, inventory, receivables, and short and intermediate-term financing), and long-run resource planning (investment in long-lived assets, leasing, debt and equity financing, dividend policy, and the cost of capital). Institutional aspects of financial markets are emphasized only to provide necessary insights into the problems of planning financial strategy. 3 units.

**356. Finance.** Management of the financial affairs of the firm in its attempt to develop an optimal capital structure: (1) the sale of corporate securities of all varieties and the related knowledge about the requirements of investors at particular points in time, and (2) the translation of plans and programs into needs which must in turn be met by cash resources from either internal or external sources. 3 units.

**359.1-.9. Research in Finance.** 1 to 6 units.

**365. Market Strategy.** Strategic problems associated with providing a set of products or services to consumers; and with procuring resources and services from suppliers that contribute to objectives of the organization. The analysis of market opportunities, product mix strategy, market segmentation, design of distribution and procurement channels, price and promotion strategy, and sales force decisions. 3 units.

**366. Marketing.** Applies the general theories previously studied to the firm's marketing problems. Definition and resolution of these problems involve a more detailed discussion of the existing market environment of the firm. Problems studied are consumer behavior, marketing structures, product planning, pricing, promotion, logistics, and marketing research. 3 units.

**369.1-.9. Research in Marketing.** 1 to 6 units.



**375. Operations Strategy.** Strategic problems associated with the design, operation, and control of the transformation processes utilized by an organization in producing goods and services for its external markets. Specific attention is given to systems design (product design, process design, capacity planning), system operation (production planning, scheduling) and system control (inventory control, quality control). 3 units.

**376. Production.** Provides the student with experience in applying the theories developed during the first three semesters to problems of professional practice in the area of production management. Major problem areas are covered—first, the design (or planning) of manufacturing systems and second, their operation (or control). Sub-topics under design include plant layout, economic evaluation of materials, methods and processes, and facilities planning. Sub-topics under operation include cost, inventory and quality control, short-run scheduling and capacity utilization, maintenance, start-up problems, and equipment replacement. 3 units.

**379.1-9. Research in Production.** 1 to 6 units.

**381. Management of Financial Institutions.** Explores various ways in which management science techniques can be applied to the management problems of financial institutions, especially commercial banks. The course will examine several types of financial institutions, consider the role that they play in the American economy, and focus on the use of management science techniques for helping executives cope with planning, decision-making, and control problems. 3 units.

**382. Multinational Enterprise.** Focuses on the nature and consequences of multinational corporations. Studies the international economic environment in which multinational corporations operate, the problems of managing a multinational corporation, and the public policy toward multinational corporations. 3 units.

**385. Strategy of the Organization I.** The problems of formulating strategy for the organization, of decomposing aggregate strategy problems into manageable sub-problems, and of integrating and coordinating strategies designed for sub-problems into a consistent and implementable strategy for the organization as a whole. Specific attention is given to objectives of the organization in a complex environment, the objective setting process, short- and long-run strategy planning, methods for decomposing strategy planning, mechanisms for achieving integration and coordination of strategy, and the role of management information systems in strategy planning. 2 units.

**386. Strategy of the Organization II.** Integrates the strategy planning and control process, organization design, and management information systems in order to achieve the objectives of the organization. Strategy formulation, implementation, and control from the viewpoint of the organization as a whole and to the design of structures for the coordination and control of the organization. The cooperation and competitive relations of the firm with its environment are also investigated. 4 units.

**390. The Practicum.** A significant experience in applying the concepts, theories, and methods of analysis learned in the program to a real, complex problem of an economic enterprise. It should include the analysis of a situation and the explicit formulation of a problem. The important task of identifying and specifying the problem is an integral part of the practicum.

The practicum report should propose a solution to the problem and should contain the supporting explanation and logic. The solution should be one that can be implemented, not requiring unavailable resources. 3 units.

**391.1-.9. Special Topics in Management.** Elective courses may be offered as special topics in management on an occasional basis depending on the availability and interests of students and faculty. Such courses might pertain to management of the nonprofit enterprise, advanced organization theory, marketing research, or manpower planning. 1 to 5 units.

**392-393. Tutorial in Interdisciplinary Areas.** 1 to 6 units.

**397. Dissertation Research.** 1 to 6 units.

## Chemistry

Professor Krigbaum, *Chairman* (101 Gross Chemical Laboratory); Professor Jeffs, *Director of Graduate Studies* (329 Gross Chemical Laboratory); Professors Bradsher, Chesnut, Hobbs, McPhail, Poirier, Quin, Smith, Strobel, Wells, and Wilder; Associate Professors Baldwin, Crumbliss, Henkens, Lochmüller, Palmer, and Porter; Assistant Professors Baier, Gutknecht, Luken, Neilson, and Shaw; Adjunct Associate Professors Ghirardelli, Pitt, Rosenthal, and Spielvogel

In the Department of Chemistry graduate work is offered leading to the A.M. and Ph.D. degrees. Before undertaking a graduate program in chemistry, a student should have taken an undergraduate major in chemistry, along with related work in mathematics and physics.

Graduate courses in the department are offered in the fields of analytical, inorganic, organic, and physical chemistry. Research programs are active in all these fields.

A booklet providing detailed information on the department is available from the Director of Graduate Studies.

### For Seniors and Graduates

**201. Molecular Spectroscopy.** Selected spectroscopic methods in the study of molecular structure. Symmetry and group theoretical basis for selection rules, theories of magnetic and optical resonance, and interpretation of spectra; examples from both inorganic and organic chemistry. Three lectures. Prerequisite: consent of department. 3 units. *Staff*

**203. Quantum Chemistry.** Basic principles of quantum and group theoretical methods. Topics include symmetry, a review of the fundamentals and the mathematical foundation of quantum theory. Emphasis on the application of molecular orbital theory to organic and inorganic systems. Three lectures. Prerequisite: consent of department. 3 units. *Staff*

**205. Structure and Reaction Dynamics.** Structure and mechanisms in organic and inorganic compounds, substitution reactions, linear free energy relations, and molecular rearrangements. Emphasis on the use of kinetic techniques to solve problems in reaction mechanisms. Three lectures. Prerequisite: consent of department. 3 units. *Staff*

**207. Principles of Thermodynamics, Diffraction, and Kinetics.** Three lectures. Prerequisite: consent of department. 3 units. *Staff*

**230. Environmental Oceanography.** Chemical, biological, and geological aspects of pollution in the marine environment. Anthropogenic effects upon natural marine processes on shore lines and shelves. Application of marine science to utilization of marine resources. Prerequisite: consent of instructor; physical chemistry is recommended. (Also listed as Marine Sciences 230.) Given at Beaufort. 6 units. *Baier and Staff*

**240. Chemical Oceanography.** Distribution, alteration, and transport of chemical species in the marine environment. Field cruises to gather samples for evaluating chemical processes in the ocean. Lectures, laboratory work, and field trips. Prerequisite: consent of instructor; physical chemistry is recommended. (Also listed as Marine Sciences 240.) Given at Beaufort. 6 units. *Baier and Staff*

**275, 276. Advanced Studies.** (1) Analytical chemistry; (2) inorganic chemistry; (3) organic chemistry; and (4) physical chemistry. Open to especially well prepared undergraduates by consent of department. 6 units. *Staff*

#### For Graduates

**300. Basic Statistical Mechanics.** Fundamentals of quantum and classical statistical mechanics using the ensemble approach. Emphasis on systems of weakly interacting particles with internal degrees of freedom. 3 units. *Staff*

**302. Basic Quantum Mechanics.** The fundamentals of quantum mechanics with special emphasis on chemical applications. Topics included are: linear algebra, the uncertainty relations, angular momentum, perturbation theory and time dependent phenomena, molecules in electromagnetic fields, group methods, and electron correlation. 3 units. *Staff*

**303, 304. Special Topics in Physical Chemistry.** Presentation of one or more topics of staff interest such as advanced methods in crystallography, light scattering and small angle X-ray diffraction, application of ESR spectroscopy to chemical problems, electronic spectroscopy of proteins, group theory, inter-molecular forces, liquid crystals, methods of determining the rates of elementary steps in reaction kinetics, physical chemistry of aerosols, physical-chemical methods of polymer characterization, structure and bonding in metallo-enzymes, statistical mechanics of fluids, topics in structural chemistry, and triplet excitons. 1 to 3 units each semester. *Staff*

**310. Theoretical and Structural Inorganic Chemistry.** An advanced study of theoretical concepts and structural determination techniques as applied to inorganic systems. Areas included are crystal field and ligand field theories, magnetic susceptibility, and electronic, infrared, and Raman spectroscopy. 3 units. *Crumbliss or Palmer*

**312. Inorganic Reactions and Mechanisms.** Chemistry of main group and transition elements. Emphasis on current developments in synthetic and mechanistic studies of inorganic, organometallic, and organometalloid compounds. 3 units. *Crumbliss or Wells*

**313, 314. Special Topics in Inorganic Chemistry.** Lectures, oral reports, and discussions on advanced topics and recent advances in the field of inorganic chemistry. Examples of topics which may be discussed are bioinorganic chemistry, fluxional molecules, homogeneous catalysis, synthesis and properties of selected groups of compounds, and new physical methods. 1 to 3 units each semester. *Staff*

**320. Synthetic Organic Chemistry.** A study of the scope and limitations of the more important types of reactions in synthetic organic chemistry. Some discussion of the rapidly developing use of transition metals, complex hydrides, and photochemistry will be included. 3 units. *Baldwin or Bradsher*

**322. Organic Reactive Intermediates.** A discussion of reactive intermediates in organic chemistry. Topics will include carbanions, carbenes, carbonium ions, free radicals, photochemical excited states, and other reactive species. 3 units. *Porter or Wilder*

**323, 324. Special Topics in Organic Chemistry.** Advanced topics and recent developments in the field of organic chemistry. Each year heterocyclic chemistry or the chemistry of natural products will be among the topics presented. Lectures, and written and oral reports. 1 to 3 units each semester. *Staff*

**330. Chemical Separation Methods and Kinetics in Analytical Chemistry.** The principles of rate processes and diffusion; plate-theory, adsorption and chemical selectivity. Thermodynamics of processes leading to differential migration in chromatography. Kinetic methods of analysis with emphasis on the quantitative determination of concentration in biological and non-biological systems. 3 units. *Staff*

**331, 332. Special Topics in Analytical Chemistry.** An advanced treatment of important areas in modern analysis. Possible topics include: electrochemistry, small computer applications, magnetic resonance, and problem-solving approaches. 1 to 3 units each semester. *Staff*

**334. Chemical Instrumentation and Applied Spectroscopy.** Principles of instrumental design. Topics covered include input transducers, dispersive devices, servo systems, operational amplifiers, and digital logic. An introduction to advanced topics in analytical spectroscopy. Fourier transform methods in infrared and n.m.r. spectroscopy, X-ray fluorescence, applications of lasers to high-speed measurements, and fast-scan spectrophotometry. 3 units. *Staff*

**373, 374. Seminar.** Required of all graduate students in chemistry. One hour a week discussion. 1 unit each semester. *All Members of the Graduate Staff*

**375, 376. Research.** The aim of this course is to give instruction in methods used in the investigation of original problems. Individual work and conferences. 1 to 6 units. *All Members of the Graduate Staff*

**377. Research Orientation Seminar.** A survey of departmental research. Required of all entering graduate students in chemistry. Prerequisite: consent of the Director of Graduate Studies. 1 unit. *All Members of the Graduate Staff*

## Classical Studies

Professor Oates, *Chairman* (325 Carr); Professor Newton, *Director of Graduate Studies* (326 Carr); Professors Richardson and Willis; Associate Professor Stanley; Assistant Professors Burian and Rigsby; Visiting Lecturer Levy

The Department of Classical Studies offers two programs leading to the Ph.D. degree, one with emphasis on literature and philology, the other with emphasis on ancient history and archeology. For regular admission to the program in literature and philology, a student must offer three years of college study above the elementary level in one of the classical languages and two college years in the other. Students wishing to enter the program in ancient history and archeology will be required on entrance to demonstrate satisfactory competence in both Greek and Latin for reading in the primary sources; failure to demonstrate such competence will require modification of the student's program to repair the deficiency.

The department's special requirements, in addition to the general requirements of the University for the Ph.D. degree set forth in the section on Program Information of this *Bulletin*, are presented in a sheet that may be obtained from the Director of Graduate Studies. They include special requirements in seminars, course work, and the preliminary examination for the Ph.D. degree.

A reading knowledge of German and French is required of all candidates for the Ph.D. degree. The candidate should meet one of the language requirements by the end of the first term in residence and the other by the end of the third term.



## GREEK

### For Seniors and Graduates

**200. Graduate Reading.** Open to qualified undergraduates by consent of the instructor. 3 units. *Stanley*

**203. Homer.** The *Iliad* and *Odyssey*; the problems of language and structure in the epic; present state of Homeric scholarship. 3 units. *Levy or Stanley*

**205. Greek Lyric Poets.** Fragments of the early lyric poets; selected odes of Pindar and Bacchylides. 3 units. *Burian*

**206. Aeschylus.** The *Oresteia*, with study of the form of *Agamemnon* and its place in the design of the trilogy. 3 units. *Willis*

**208. Sophocles.** The Theban plays; the structure and style of Sophoclean tragedy. 3 units. *Stanley*

**209. Euripides.** Representative tragedies in their political and philosophical context; analysis of dramatic form and texture. 3 units. *Stanley*

**210. Aristophanes.** Origin and development of Greek comedy; representative plays of Aristophanes. 3 units. *Burian*

**221. Early Greek Prose.** Greek prose in the fifth century from the Ionian scientists and logographers to Herodotus, Gorgias, Antiphon, and the Old Oligarch. 3 units. *Willis*

**222. Thucydides.** The *History*; Thucydides' historical method and style. 3 units. *Willis*

**223. Greek Orators I.** Early fourth-century rhetoric, including Andocides, Lysias, and Isocrates. 3 units. *Staff*

**224. Greek Orators II.** Aeschines' *Against Ctesiphon* and Demosthenes' *On the Crown* in the light of fourth-century political history and rhetorical development. 3 units. *Willis*

**225. Plato.** Selected dialogues and related passages illustrating the development of philosophical topics and stylistic motifs. 3 units. *Stanley*

**231. Hellenistic Poetry.** The principal lyric, elegiac, pastoral, and didactic poets of Alexandria; emphasis on Callimachus and Theocritus. 3 units. *Stanley*

**241. Advanced Prose Composition.** Xenophon, Lysias, and other prose authors as models of style and practice in the writing of Attic prose. 1 unit. *Willis*

### For Graduates

(At least two of these are offered each year.)

**301. Greek Seminar I.** 3 units.

**302. Greek Seminar II.** 3 units.

**303. Greek Seminar III.** 3 units.

**304. Greek Seminar IV.** 3 units.

**305. Greek Seminar V.** 3 units. *Stanley*

**306. Greek Seminar VI.** 3 units. *Oates*

**311. Proseminar in Papyrology.** 3 units. *Willis*

313. **Proseminar in Greek Epigraphy.** 3 units. *Rigsby*
321. **Seminar in Literary Papyri.** 3 units. *Willis*
323. **Seminar in Documentary Papyri.** 3 units. *Oates*
399. **Directed Reading and Research.** Credit to be arranged. *Stanley*

## LATIN

### For Seniors and Graduates

**200. Graduate Reading.** Open to qualified undergraduates by consent of the instructor. 3 units. *Newton or Younger*

**201. The Verse Treatise.** The genre of didactic poetry; emphasis on Lucretius' *De Rerum Natura*, Vergil's *Georgics*, and Ovid's *Ars Amatoria*; attention to Cicero's *Aratea*, the *Astronomica* of Manilius, Horace's *Ars Poetica*, and Ovid's *Fasti*. 3 units. *Newton or Richardson*

**202. Roman Satire.** A survey of the genre with concentration on Horace, Juvenal, and Persius. 3 units. *Richardson*

**203. Epic: Vergil.** The *Aeneid*. 3 units. *Newton*

**204. Epic: Lucan and Statius.** The development of the Roman epic in the Silver Age. 3 units. *Richardson*

**207. The Prose Epistle.** The letter as a vehicle of communication and as a literary form. 3 units. *Richardson*

**208. The Epistle in Verse.** The letter as a literary form; reading in the *Epistles* of Horace, the *Heroides* of Ovid, and Statius. 3 units. *Staff*

**209. Fragments of Early Latin.** The remains of Latin poetry of the third and second centuries B.C., from Livius Andronicus to Lucilius, with emphasis on the epic and drama of Ennius. 3 units. *Stanley*

**210. Lyric and Occasional Poetry.** Shorter verse forms: epigram, pastoral, song, and panegyric. 3 units. *Staff*

**211. Roman Oratory I.** The literary history and criticism of Roman oratory. 3 units. *Richardson*

**212. Roman Oratory II.** A continuation of Latin 211. 3 units. *Staff*

**221. Medieval Latin I.** Latin literature of late antiquity, from Prudentius to the Carolingian Revival. 3 units. *Newton*

**222. Medieval Latin II.** Literature in Latin from Charlemagne to the Renaissance. 3 units. *Newton*

**225. Latin Paleography.** Latin book hands from the Roman Empire to the Italian Renaissance. 3 units. *Newton*

**241. Advanced Latin Composition.** Experiments in imitation of the great Latin prose styles and introduction to the composition of verse. 1 unit. *Richardson*

**250. Teaching Latin.** Objectives, methods, and problems; the study of textbooks, programs, and related materials. 3 units. *Staff*

### For Graduates

(At least two of these are offered each year.)

- 301. Latin Seminar I. 3 units.
- 302. Latin Seminar II. 3 units.
- 303. Latin Seminar III. 3 units.
- 304. Latin Seminar IV. 3 units.
- 305. Latin Seminar V. 3 units. *Richardson*
- 306. Latin Seminar VI. 3 units. *Newton*
- 312. Proseminar in Latin Paleography. 3 units. *Newton*
- 314. Proseminar in Latin Epigraphy. 3 units.
- 315. Proseminar in Roman Law. 3 units.
- 399. Directed Reading and Research. Credit to be arranged. *Newton*

## CLASSICAL STUDIES

### For Graduates

- 301. **Introduction to Classical Philology.** Introduction to the bibliography and principal disciplines of the field. 3 units. *Willis and Graduate Staff*
- 351. **The Teaching of Classics.** The student is introduced to the problems involved in teaching the classics. Regular classroom observation and some teaching experience. No credit. *Staff*

## CLASSICAL STUDIES (ANCIENT HISTORY)

- 253. **Greece to the Orientalizing Period.** 3 units. *Rigsby*
- 254. **The Age of the Tyrants and the Persian Wars.** 3 units. *Oates*
- 255. **The Age of Pericles.** 3 units. *Oates*
- 256. **The Fourth Century through Alexander.** 3 units. *Oates*
- 257. **Social and Cultural History of the Hellenistic World from Alexander to Augustus.** 3 units. *Rigsby*
- 258. **Social and Cultural History of the Graeco-Roman World.** 3 units.
- 260. **The History of Rome to 146 B.C.** 3 units. *Staff*
- 261. **The Roman Revolution, 146-30 B.C.** 3 units. *Rigsby*
- 262. **Rome under the Julio-Claudians.** 3 units. *Staff*
- 263. **From the Flavian Dynasty to the Severan.** 3 units. *Staff*
- 264. **From Septimius Severus to Constantine.** 3 units. *Staff*
- 270. **The Rise of the Hellenistic Kingdoms.** 3 units. *Oates*
- 271. **The Hellenistic World, 250-31 B.C.** 3 units. *Oates*

### For Graduates

(At least two of these are offered each year.)

- 321. **Seminar in Ancient History I.** 3 units.
- 322. **Seminar in Ancient History II.** 3 units.

323. Seminar in Ancient History III. 3 units.
324. Seminar in Ancient History IV. 3 units.
325. Seminar in Ancient History V. 3 units. *Oates*
326. Seminar in Ancient History VI. 3 units. *Oates*
327. Seminar in Byzantine History. 3 units. *Rigsby*
399. Directed Reading and Research. Credit to be arranged. *Staff*

## CLASSICAL STUDIES (ARCHEOLOGY)

### For Seniors and Graduates

**231S. Greek Sculpture.** Techniques and styles of the major schools and personalities in archaic, classical, and Hellenistic free-standing and architectural sculpture. 3 units. *Stanley*

**232S. Greek Painting.** Techniques and style in the various media; emphasis on the problems of chronology, attribution, and iconography of Attic pottery. 3 units. *Stanley*

**235S. Roman Architecture.** Significant monuments chosen to exemplify the Roman genius in building in the late Republic and early Empire. 3 units.

**236S. Roman Painting.** Roman pictorial art with concentration on the wall paintings from Campania. Investigation of techniques, iconography, and the use of pictures in decoration. 3 units. *Richardson*

### For Graduates

(One course is offered each year.)

**311. Archeology Seminar I.** 3 units. *Richardson and Stanley*

**312. Archeology Seminar II.** 3 units. *Younger*

Under the terms of a cooperative agreement, graduate students of Duke University may, with the approval of the chairman of their major department and upon payment of a nominal fee, take any graduate course offered by the Department of Classics of the University of North Carolina. A list of these courses will be sent upon request.

## Comparative Literature

No graduate degree is offered in comparative literature. The following courses may serve, however, in the minor programs of students in other departments. Consult Professor Wardropper in the Department of Romance Languages.

**220S. Comparative Literature Seminar.** Topics vary. 3 units. *Jantz*

**280. Criticism.** Emphasis on structuralist and post-structuralist theories and their antecedents. Lectures and discussion by an interdepartmental team. 3 units. *Stewart*

## Computer Science

Professor Loveland, *Chairman* (202 North); Assistant Professor Gerhart, *Director of Graduate Studies* (201 North); Professors Clarke, Gallie, Marinos, Naylor, and



Woodbury; Associate Professors Hammond, Patrick, and Starmer; Assistant Professors Biermann, Foster, Ramm, and Trivedi; Adjunct Associate Professor Williams

The Department of Computer Science offers programs leading to the A.M. and Ph.D. degrees.

A student entering graduate work in computer science should have a knowledge of mathematics through advanced calculus and of at least two computer programming languages. Research interests of present faculty include mathematical foundations of computer science, artificial intelligence, program verification, programming languages, real-time computing, operating systems, information storage and retrieval, computer design, simulation of systems of interest to social scientists, and numerical analysis.

### For Seniors and Graduates

**200. Programming Methodology.** Practical and theoretical topics including structured programming, specification and documentation of programs, debugging and testing strategies, choice and effective use of programming languages and systems, psychology of computer programming, proof of correctness of programs, analysis of algorithms, and properties of program schemata. Prerequisite: Computer Science 152. 3 units. *Gerhart*

**201. Programming Languages.** Information binding, data structures and storage, control structures, recursion, execution environments, input/output; syntax and semantics of languages; study of PL/I, Fortran, Algol, APL, LISP, SNOBOL, and SIMULA; exercises in programming. Prerequisite: Computer Science 200. 3 units. *Clarke or Gerhart*

**208. Digital Computer Design.** (Also listed as Electrical Engineering 208.) 3 units. *Marinos or Owen*

**215. Artificial Intelligence.** Heuristic versus algorithmic methods; programming of games such as chess; theorem proving and its relation to correctness of programs; readings in simulation of cognitive processes, problem-solving, semantic memory, analogy, adaptive learning. Prerequisite: Computer Science 152 or consent of instructor. 3 units. *Biermann*

**221. Numerical Analysis I.** Error analysis and interval arithmetic, interpolation and polynomial approximation methods, numerical differentiation and integration, solution of simultaneous linear equations and matrix inversion, real and complex roots of nonlinear equations. Prerequisites: knowledge of an algorithmic programming language and intermediate calculus. (Also listed as Mathematics 221.) 3 units. *Gallie or Patrick*

**222. Numerical Analysis II.** Calculation of eigenvalues and eigenvectors, numerical methods for solving ordinary differential equations, partial differential equations, and integral equations. Prerequisite: Computer Science 221 or equivalent. (Also listed as Mathematics 222.) 3 units. *Patrick or Utku*

**223. Numerical Optimization.** Numerical methods for finding minima of functions of several or many variables, with and without conditions of constraint. Prerequisite: Computer Science 221 or equivalent. (Also listed as Mathematics 223.) 3 units. *Staff*

**225. Mathematical Foundations of Computer Science I.** Introduction to basic concepts and techniques used in mathematical models of computation. Elements of the predicate calculus; applications to automatic theorem proving and verification

of programs. Notions of computable sets, functions, algorithmically unsolvable problems. Regular and context-free formal languages and the machines that define them. Prerequisite: four semesters of college mathematics. 3 units. *Biermann or Loveland*

**226. Mathematical Foundations of Computer Science II.** Basic concepts and techniques used in the modeling of systems. Elements of probability, statistics, queuing theory, linear programming, linear systems, and error analysis. Prerequisites: four semesters of college mathematics. 3 units. *Foster*

**231. Introduction to Operating Systems.** Characteristics and components of operating systems and methods for their implementation. Program linkage and relocation, job scheduling, resource allocation and interrupt handling, input/output control systems, on-line file structures, communication, time sharing and real time systems. Case studies of existing systems. Prerequisite: Computer Science 152. 3 units. *Foster or Trivedi*

**232. Metaprograms.** Programs which process programs: compilers, interpreters, and assemblers. Syntax and semantics of programming languages. 3 units. *Galile*

**241. Data Base Management Systems.** Basic concepts and principles. Relational, hierarchical, and network approaches to data organization; systems and language support for data base systems; theories of data organization; security and privacy issues. Prerequisites: Computer Science 150 and 152. 3 units. *Hammond*

**244. Computer Simulation Models of Economic Systems.** (Also listed as Economics 244.) 3 units. *Naylor*

**250. Clustering and Classification.** Algorithms and operating characteristics of clustering and classification methods. Data models for sequential data acquisition, clustering in terms of nearest neighbor, and/or mixtures of distributions-missing information principle. Characterization of patient groups versus normal groups and selection of measures to characterize diseases as superclusters. Application of Bayes' procedures to classification into clusters and superclusters. Prerequisite: consent of instructor. 3 units. *Woodbury*

**251. Computer Science for Teachers.** An introduction to digital computation which concentrates on computer instruction in the high school and on the employment of computer processes in instruction and school administration. Prerequisite: a year of basic mathematical analysis at the college level. Summer session. 3 units. *Staff*

**252. Computer Systems Organization.** Hardware and software aspects. Processor, memory, device, and communication subsystems; case studies of hardware system organization, e.g., parallel, associative, fault-tolerant; organization of software systems to exploit hardware systems organization; economic and reliability aspects of various hardware organizations. Prerequisites: Computer Science 150 and 157. *Trivedi*

**265. Advanced Topics in Computer Science.** 3 units. *Staff*

**301. Topics in Programming Theory.** Advanced topics in theory of programming will be selected from areas of current research. Prerequisite: Computer Science 201 or consent of instructor. 3 units. *Clarke or Gerhart*

**307. Advanced Digital Systems I.** See course description for Electrical Engineering 307. (Also listed as Electrical Engineering 307.) 3 units. *Marinos*

**308. Advanced Digital Systems II.** See course description for Electrical Engineering 308. (Also listed as Electrical Engineering 308.) 3 units. *Marinos*

**315. Advanced Artificial Intelligence.** Course content will vary from year to year and will include a detailed study of one or more of the following: mechanical theorem proving, natural language processing, automatic program synthesis, machine learning and inference, representations of knowledge, languages for artificial intelligence research, artificial sensorimotor systems, and others. Prerequisite: Computer Science 215. 3 units. *Biermann*

**321. Topics in Numerical Mathematics.** Advanced topics in numerical mathematics to be selected from areas of current research. Prerequisites: Computer Science 221 and 222 or 223. 3 units. *Gallie or Patrick*

**325. Theory of Computation.** Elements of recursive function theory: s-m-n theorem, recursion theorem. Abstract computational complexity: essentially complex functions, Blum speed-up theorem. Concrete complexity and analysis of algorithms, e.g., matrix multiplication. Subrecursive hierarchies: the deterministic and non-deterministic polynomial bound hierarchies. Program schemata. Techniques for proving properties of programs. Emphasis among above topics will vary from year to year. Prerequisite: Computer Science 225 or equivalent. 3 units. *Love-land*

**326. Systems Modeling.** Advanced study of analytical models of systems; queuing model and its parameterization and validation. Methods for computer solutions of some models. Prerequisites: Computer Science 226 and 231. 3 units. *Foster or Trivedi*

**331. Operating Systems Theory.** Advanced study of theoretical aspects of operating systems emphasizing models and control of concurrent processes, processor scheduling, and memory management. Prerequisites: Computer Science 226 and 231. 3 units. *Foster or Trivedi*

**332. Topics in Operating Systems.** Advanced topics in operating systems to be selected from areas of current research. Prerequisite: Computer Science 331. 3 units. *Foster or Trivedi*

**344. Workshop on Computer Models of Social Systems.** See course description for Economics 344. (Also listed as Economics 344 and Political Science 344.) 3 units. *Naylor*

## Economics

Professor Kelley, *Chairman* (215A Social Science); Professor Weintraub, *Director of Graduate Studies* (315 Social Science); Professors Blackburn, Bronfenbrenner, Davies, Goodwin, Grabowski, Kreps, Lewis, Naylor, Saville, Trembl, Vernon, Wallace, and Yohe; Associate Professors de Marchi, Graham, Havrilesky, McElroy, and Tower; Assistant Professors Bolnick, Cook, Lipscombe, Weymark, and Wyse

The Department of Economics offers graduate work leading to the A.M. and Ph.D. degrees. Among the undergraduate courses of distinct advantage to the graduate student in economics are statistics, economic theory, and basic courses in philosophy, mathematics, and social sciences other than economics. Advanced work in mathematics or statistics is also useful.

Requirements for the Ph.D. degree in economics include examination in economic theory at the end of the first year, and, at the end of the second year, an examination in economic analysis. In addition a student must obtain certification in three fields, one of which may be in an outside minor. The student may select from

advanced economic theory, history of political economy, economic development, economic history, international economics, money and banking, labor economics, public finance, industrial organization, econometrics, statistics, Soviet economics, and certain fields outside the economics department (e.g., demography). Course work for the Ph.D. degree should be completed in four semesters of residence.

### For Seniors and Graduates

**200. Capitalism and Socialism.** Selected ideological classics of new and old right and left economics including both "counsels for perfection" (Utopias) and "precepts for action" in political economy. Prerequisite: Economics 149 or 154, or consent of instructor. 3 units. *Bronfenbrenner*

**204S. Advanced Money and Banking.** Monetary theory and its statistical and institutional implementation. Particular attention is given to the development of aggregative theories of prices, interest rates, and production; the functioning of monetary policy within various theoretical frameworks; and appraisal of the recent use and the limitations of Federal Reserve policy. 3 units. *Havrilesky or Yohe*

**231S. Economic Development of Europe.** Sequence of local, national, and international economic structures under situations of changing trade, industry, agriculture, population, investment, war conditions, public ownership, cartels, colonialism, and prices. 3 units. *Saville*

**232. Economic History of Japan.** Japanese economic development, stressing the period since the end of isolation. Prerequisite: one semester of economic analysis or of Far Eastern history. (Also listed as History 260.) 3 units. *Bronfenbrenner*

**233. State and Urban Finance.\*** Expenditures, taxation, and financial administration in state and local governments, with emphasis on current problems. Special attention will be given to research methods and materials, and to the financial relations between state and local governments. 3 units. *Davies or Wyse*

**237, 238. Statistical Methods.** A study of statistical methods appropriate for dealing with problems in business and social science. In addition to developing more thoroughly the subject considered in business statistics, the following methods will be considered: simple, multiple, partial, and curvilinear correlation; curve fitting; probability; sampling distributions; and statistical inference. Prerequisite: Economics 138 or consent of the instructor. 6 units. *Staff*

**243. Econometrics I.** Economic theory, mathematics, statistical inference, and electronic computers applied to analysis of economic phenomena. Objective is to give empirical content to economic theory. Matrix algebra used to develop topics in inference, linear regression, and systems of simultaneous equations. Use is made of the electronic computer. 3 units. *Naylor or Wallace*

**244. Computer Simulation Models of Economic Systems.** A course on the design of computer simulation experiments for economic systems. Topics include generation of stochastic variates, computer models of queuing and inventory systems, models of the firm and industry, models of the economy, simulation languages, and experimental design. (Also listed as Computer Science 244.) 3 units. *Naylor*

**245. Econometrics II.** Advanced theory and applications: includes specification error, generalized least squares, lag structures, Bayesian decision-making, simulta-

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\*Offered on demand.



neous equation methods, and forecasting. Emphasis on current applied literature. A Track 1, third-level course. Prerequisite: Economics 243. 3 units. *McElroy or Wallace*

**257. Manpower and Human Resources.** Allocation of human resources; returns to investments in education and training; qualitative composition of the labor force. *Kreps*

**262. Trade Unionism and Collective Bargaining.** An intensive survey of the trade union as an economic institution is followed by a study of the principles and problems of union-management relationship as found in collective bargaining. 3 units. *Staff*

**265S. International Trade and Finance.** A study of fundamental principles of international economic relations. Subjects covered include the economic basis for international specialization and trade, and the economic gains from trade, the balance of international payments, problems of international finance, investments, and monetary problems. Prerequisite: Economics 149. 3 units. *Bronfenbrenner or Tower*

**287. Public Finance.** Economic aspects of such problems as the growth of government, the proper role of the state, the centralization and decentralization of government, government bureaucracy, the impact of taxes and spending on the wealthy and the poor as well as other public policies and questions. 3 units. *Davies*

**293. Soviet Economic History.** Establishment of foundations of a socialist economy: collectivization, industrialization, and search for economic efficiency. 3 units. *Trembl*

**294S. Soviet Economic System.** Economic planning and administration in the Soviet Union and other socialist countries. International comparisons. Theoretical and applied problems of resource allocation, economic development, and optimal microdecision-making in a nonmarket economy. 3 units. *Trembl*

## For Graduates

**301. Microeconomic Analysis I.** Review of contemporary theory relating to production, the firm, and income distribution in competitive and imperfectly competitive markets. 3 units. *Graham*

**302. Microeconomic Analysis II.** A continuation of Economics 301 with emphasis on analyses of consumer behavior, general equilibrium, welfare economics, and capital theory. Prerequisite: Economics 301. 3 units. *Weintraub or Weymark*

**303. Theory of Economic Decision-making.** The extension of economic theory to the allocation of resources within firms and governmental units. Prerequisite: Economics 301 or equivalent. 3 units. *Graham or Weymark*

**304, 305. Monetary Theory and Policy.** In the first semester: theories of the supply of and demand for money (neoclassical and Keynesian macroeconomic), general equilibrium theories, and theories of the term structure of interest rates. In the second semester: the theory and practice of the monetary policy with emphasis on recent issues, the monetarist-fiscalist controversy, the monetary policy transmission mechanism, and policy simulations with econometric models. 3 units each semester. *Havrilesky or Yohe*

**307. Quantitative Analysis I.** A systematic analysis of the principal quantitative methods used in microeconomic theory. Neoclassical theories of production and distribution are used as vehicles for presenting the material. Considerable em-

phasis is placed on the application of mathematical analysis to economic models. 3 units. *McElroy*

**308. Quantitative Analysis II.** Linear economic models, particularly Leontief models, are used in the exposition. Primary emphasis is placed on the application of mathematics to economic theory. Prerequisite: Economics 307 or consent of instructor. 3 units. *Graham*

**311, 312. History of Political Economy.** A detailed review of the development of economic theory, the tools of economic analysis, and economics as a science, together with an analysis of the circumstances affecting this development. Period covered: pre-Christian times through 1936. 3 units each semester. *Goodwin*

**313, 314. Seminar in Economic Theory.** Prerequisite: Economics 301 or equivalent. 3 units each semester. *Weintraub*

**316. Seminar in Economics of Soviet-Type Socialism.** Selected topics in analysis of theoretical and institutional framework of Soviet economic system, such as markets versus plan, optimizing techniques in planning, price determination balanced economic development, and ideology and economic policy. 3 units. *Trembl*

**317. Seminar in Demographic, Population, and Resource Problems.** 3 units. *Kelley*

**318. Dissertation Seminar.** 3 units. *Staff*

**319. Seminar in the Theory and the Problems of Economic Growth and Change.** 3 units. *Staff*

**320. Macroeconomic Analysis I.** Measurement of national income and other important aggregates; classical macroeconomics; Keynesian and more recent views of the determinants of income, employment, and price levels; empirical studies of consumption, investment, and monetary variables. 3 units. *Bronfenbrenner*

**321. Theory of Quantitative Economic Policy.** The use of mathematical models in analyzing the connections between means and ends of economic policy; topics covered include principles and design, centralization and decentralization, stabilization and growth policies, welfare optimization, imperfect models, and the use of control system analysis. Prerequisite: Economics 320. 3 units. *Staff*

**322. Macroeconomic Analysis II.** Further analysis of topics treated in Economics 320. Optimal economic growth; business cycles. Issues in economic policy. Prerequisite: Economics 320. 3 units. *Graham or Weintraub*

**323. Income Distribution Theory.** Income distributions—functional and personal. Concepts and measures of poverty and inequality. Maldistribution issues—ethical and economic. Pricing of productive services, primary attention on wages and employment. Rival aggregative (macro-distribution) theories. Prerequisites: intermediate micro- and macro-economics and some knowledge of calculus and statistics. *Bronfenbrenner*

**329. Federal Finance.** An analysis of the trends and hypotheses concerning the growth in governmental activity, the optimum level and composition of governmental spending, and the microeconomic and macroeconomic effects of governmental spending and tax policies. 3 units. *Davies*

**330. Seminar in Public Finance.** 3 units. *Wyse*

**331. Seminar in Economic History.** 3 units. *Staff*

**344. Workshop on Computer Models of Social Systems.** A course on the

methodology of constructing computer simulation models of social systems including political, economic, social, administrative, and educational. Although the emphasis of the course is on a variety of different types of models of social systems, special consideration is given to the methodology of designing simulation experiments. (Also listed as Computer Science 344, Political Science 344, and Sociology 344.) 3 units. *Naylor*

**345, 346. Demographic Techniques I and II.** (Also listed as Sociology 345, 346.) 3 units each semester. *Myers*

**350. Seminar in Applied Economics.** A course that will use the principles of micro-economics in the analysis of problems and policies. The particular contextual materials that will be subjected to analysis will vary from time to time. Materials will be treated in the tradition of positive economics.

**355. Seminar in Labor Economics.** 3 units.

**358. Seminar in Labor Market and Related Analysis.** 3 units. *Staff*

**365. Seminar in International Trade Theory.** 3 units. *Tower*

**366. Seminar in International Monetary Theory.** The monetary, as opposed to the pure, side of international economics. Among the topics considered are the balance of payments, the foreign-exchange market capital movements, payments equilibrium, the demand for reserves, and international monetary reform. 3 units. *Tower*

**388. Industrial Organization.\*** The theory, measurement, and history of the firm-structure of industry. Emphasis upon the structure of American industry and upon actual production and pricing practices. Criteria for evaluating industrial performance. 3 units. *Vernon or Grabowski*

**389. Seminar in Industrial and Governmental Problems.\*** 3 units. *Vernon*

**397, 398. Directed Research.**

**401. Seminar on the British Commonwealth.** 3 units. *Ball, Preston, and Others of the Committee on Commonwealth Studies*

**402. Interdisciplinary Seminar in the History of the Social Sciences.** 3 units. *Goodwin, Holley, and Spragens*

### **Related Courses in Other Departments**

Courses in related fields may be selected from anthropology, computer science, forestry, history, mathematics, philosophy, political science, public policy sciences, and sociology, or from an area that complements the candidate's area of research interests in economics.

See Program in Comparative Studies on Southern Asia and the Center for Demographic Studies in the chapter on Special and Cooperative Programs for further information.

## **Education**

Professor Flowers, *Chairman* (213 West Duke); Professor Petty, *Director of Graduate Studies* (06B West Duke); Professors Adams, Cartwright, S. Gehman, Githens,

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\*Offered on demand.

Hopkins, Hurlburt, Katzenmeyer, Shuman, and Weitz; Associate Professors Balantyne, Carbone, Colver, Davis, Di Bona, Johnson, Martin, Pittillo, and Sawyer; Assistant Professor Lehane; Lecturers Fowler, I. Gehman, Leach, and Williams

Graduate work in education is offered leading to the A.M., the M.Ed., the M.A.T., the Ed.D., and the Ph.D. degrees. For each of these degrees there are specific requirements and prerequisites, all of which may be found stated in detail in this *Bulletin*. Departmental requirements and prerequisites for all of these degrees may be obtained from the Director of Graduate Studies.

From the courses listed below, plus several in related disciplines, a selection may be made which will meet North Carolina requirements for the Advanced Principal's Certificate, the Superintendent's Certificate, and the Supervisor's Certificate.

(Some courses below are offered only in the summer session; see the *Bulletin of the Summer Session*.)

These programs are accredited by the National Council for Accreditation of Teacher Education for the preparation of elementary and secondary school teachers and school service personnel with the doctor's degree as the highest degree approved.

### For Seniors and Graduates

**201. Mathematics Program in the Elementary School.** Objectives, curriculum, and instructional strategies. 3 units. *Petty or Williams*

**202. Comparative and International Education: Industrialized Nations.** Structure and functioning of educational institutions in selected developed societies. Relevant social science theory and methods. 3 units. *Di Bona*

**203. Seminar in Philosophical Analysis of Educational Concepts.** Selected writings of contemporary philosophers; emphasis on such educational concepts as teaching, learning, knowing, understanding, indoctrination, explanation, and education. 3 units. *Carbone*

**204. Educational Organization.** Theory and research on the processes of exchange between educational organizations and their external environments; influence on organizational structure, goals, and practices. Examining schools, colleges, and universities through a comparative approach with other forms of social organizations: hospitals, businesses, and prisons. 3 units. *Martin*

**206. Studies in the History of Educational Philosophy.** The educational views of leading thinkers in the history of Western philosophy, including Plato, Augustine, Locke, Rousseau, Kant, Whitehead, and Dewey. 3 units. *Carbone*

**207. Social History of Twentieth-Century American Education.** Twentieth-century American education in context of social and intellectual history. 3 units. *Johnson*

**209S. John Dewey.** Dewey's major writings with emphasis on his philosophy of education. 3 units. *Carbone*

**210. The Politics of Education.** (Also listed as Political Science 210.) 3 units. *Leach*

**213. Elementary School Organization and Administration.** Nursery school, kindergarten, and the elementary school. Problems of internal organization and management of elementary school and its integration with secondary school. 3 units. *Flowers, Petty, or Pittillo*



- 215S. Secondary Education: Principles.** Principles, curriculum, and methods in secondary education. Prerequisite: C average overall and in teaching field or fields. Must be accompanied by Education 216. 3 units. *Cartwright or Shuman*
- 216. Secondary Education: Internship.** Supervised internship in junior and senior high schools. Full time for half a semester. 6 units. *Cartwright or Shuman*
- 217. The Psychological Principles of Education.** Advanced study of teaching, learning, and the learner. 3 units. *Davis, Gehman, or Weitz*
- 218. Comparative and International Education: Developing Societies.** 3 units. *Di Bona*
- 219. Comparative and International Education: South Asia.** Traditional and modern educational developments in India and Pakistan. 3 units. *Di Bona*
- 221. Programs in Early Childhood Education.** Objectives and philosophy underlying programs in early childhood education. 3 units. *Staff*
- 222. New Developments in Elementary School Curriculum.** 3 units. *Staff*
- 223. Teaching the Language Arts.** Comparison of current methods and materials in the teaching of handwriting, spelling, and oral and written composition. Analysis and correction of basic difficulties. 3 units. *Adams*
- 224. Teaching the Social Studies in Elementary Schools.** 3 units.
- 225. The Teaching of History and the Social Studies.** Evaluation of the objectives, content, materials, and methods in the teaching of history and the social studies. 3 units. *Cartwright*
- 226. Teaching Developmental and Remedial Reading in the Elementary School.** Principles, methods, and materials for the development of effective reading attitudes and skills in developmental and remedial programs. 3 units. *Adams*
- 229. Assessments of Reading Disability Cases.** Standardized tests, other methods, and informal procedures used in diagnosing reading problems of elementary and secondary pupils. 3 units. *Adams*
- 230. Research Methodology in Education.** 3 units. *Sawyer*
- 232. Psychoeducational Counseling with Parents.** Individual and group counseling concerning psychoeducational problems of parents and children. Prerequisite: consent of instructor. 3 units. *Ballantyne, Davis, or S. Gehman*
- 233. Improvement of Instruction in English.** Recent developments and research techniques in the teaching of English through individual projects. Prerequisite: consent of instructor. 3 units. *Shuman*
- 234. Secondary School Organization and Administration.** Objectives and philosophy underlying the organization and administration of the secondary school. 3 units. *Flowers*
- 236. Teaching Developmental and Remedial Reading in the Secondary School.** Principles, methods, and materials for the development of effective reading attitudes and skills in developmental and remedial programs. 3 units. *Adams*
- 237. Teaching of Literature in Secondary Schools.** Conventional, adult, and transitional literature are considered. 3 units. *Shuman*
- 238. Content, Supervision, and Administration of Reading Programs.** Objectives, organization, attributes, and evaluation of reading programs. 3 units. *Adams*

**239. Teaching of Grammar, Composition, Mechanics, and Usage in Secondary School.** Recent developments. 3 units. *Shuman*

**240. Career Development.** Analysis of the world of work; socio-personal factors affecting occupational choice; theories of career development; use of occupational and educational resources. 3 units. *Ballantyne*

**241. Foundations of Counseling and Personnel Services.** Scope, principles, historical background, services, trends, and issues of counseling, and pupil personnel services. 3 units. *Ballantyne or Colver*

**243. Personality Dynamics.** Personality structure and dynamics emphasizing implications for counseling and instruction. Prerequisite: six hours of psychology or educational psychology. 3 units. *S. Gehman*

**244. Counseling Techniques.** Individual counseling techniques; diagnosis, interviewing, program planning, and counseling evaluation. Prerequisites: Education 243 and 258, or equivalent, which may be taken concurrently. 3 units. *S. Gehman*

**245. Theories of Counseling.** 3 units. *Weitz*

**246. Teaching of Mathematics.** Aims, curriculum, and classroom procedure for teaching secondary school mathematics. 3 units.

**247. Practicum in Guidance and Counseling.** Local field experience in counseling and guidance program. Minimum of 150 hours of case work and supervision. Prerequisites: Education 244 and consent of instructor. 3 units each semester. (May be repeated.) *Ballantyne, Colver, Gehman, or Weitz*

**248. Practicum in Counseling.** Individual counseling; test administration, intake interviewing, diagnosis, program planning, and report preparation and evaluation. Minimum of 150 hours of case work and conferences with the supervisor. Prerequisite: consent of instructor. 3 units each semester. (May be repeated.) *Ballantyne, Gehman, or Weitz*

**249. Exceptional Children.** Survey of major categories of exceptional children: mentally retarded, emotionally disturbed, brain-injured, learning-disabled, physically handicapped, visually and auditorily deficient, culturally deprived, and gifted. Etiology (biological and environmental factors), diagnosis, and treatment. 3 units. *Davis*

**250, 251. Teaching Emotionally Disturbed Children: Internship.** Basic principles and practices in teaching and organization of instructional materials. Work with children under supervision of a certified teacher of emotionally disturbed children. Experience in general classroom, small group, and individualized instruction. Participation in staff conferences with psychiatrists, psychologists, social case workers, and professional educators. 3 units each semester. *S. Gehman*

**253. Introduction to Law and Education.** Basic elements of legal research, with primary emphasis on concepts and procedures relevant to educational problems. Analysis of selected cases. 3 units. *Martin*

**254. Law and Higher Education.** Concepts and procedures relating to higher education. Emphasis upon court decisions. Prerequisite: Education 253 or consent of instructor. 3 units. *Flowers*

**255. Assessment of Abilities.** The selection, use, and interpretation of various instruments for predicting and evaluating the outcome of educational experiences including surveys of standardized tests of aptitude and achievement. 3 units. *Colver*

**256. Classroom Assessment of Student Achievement.** The techniques used by classroom teachers to evaluate student progress. Special emphasis will be directed to tests written by teachers. 3 units. *Colver*

**258. Assessment of Personality, Interests, and Attitudes.** Rationale, construction, use, and interpretation of standardized instruments designed for the assessment of students' interests, attitudes, and personalities. Emphasis on counseling applications. Prerequisites: Education 243 and 255, or consent of instructor. 3 units. *Colver or Weitz*

**259. Problems in Law and Education.** Current issues; researching of cases, constitutional decisions, and statutes. Prerequisite: Education 253 or consent of instructor. 3 units. *Flowers, Martin, or Pittillo*

**260. Educational Research I.** Research design, univariate quantitative methods, and applications of the computer to research problems. 3 units. *Katzenmeyer*

**261. Educational Research II.** Analysis of covariance and multiple regression, discriminant function analysis, computer applications in research. Prerequisite: Education 260 or equivalent. 3 units. *Katzenmeyer*

**262. Educational Research III.** Multivariate analysis of variance, factor analysis, cluster analysis, and path analysis. Education 262 is offered only in a block with Education 261. 3 units. *Katzenmeyer*

**266. Basic Science for Teachers.** Natural and physical science through selected readings, the use of experiments and demonstrations, construction and use of equipment, and field studies. 3 units. *Lehane*

**268. Seminar in Contemporary Educational Criticism.** 3 units. *Carbone, Di Bona, Johnson, or Martin*

**270. Junior and Community College.** History, philosophy, and roles. Introductory course for future teachers, counselors, or administrators in a two-year college. 3 units. *Hopkins or Hurlburt*

**271. Instructional Systems for College and University Teaching.** Special attention to alternative systems, and the individualization of instruction for a heterogeneous student population. 3 units. *Hopkins*

**272. Teaching Communication Skills in Early Childhood Education.** From birth to age eight with emphasis on reading readiness and language growth. 3 units. *Adams*

**273, 274. Clinical Reading Practicum.** Experiences in the diagnosis and correction of reading disabilities in elementary and secondary students. Prerequisite: consent of instructor. 6 units. *Adams*

**276. The Teaching of High School Science.** Discussion, lectures, and collateral reading related to such topics as aims, tests, curriculum, classroom and laboratory procedure, field trips, and course and lesson planning for secondary-school science. 3 units. *Staff*

**285. Audiovisual Aids in Education.** Aims and psychological bases of audiovisual materials in the classroom. Offered in summer only. 3 units. *Staff*

**291. Public and Community Relations of Schools.** 3 units. *Hurlburt*

## For Graduates

**300. Individual Assessment of Intelligence.** Individual intelligence as meas-

ured by standardized individual instruments, chiefly the Wechsler Intelligence Test for Children and the Stanford-Binet L-M. Theory, administration, scoring, analysis, interpretation, and reporting. Work with children in supervised school settings. Prerequisite: consent of instructor. 3 units. *Davis*

**301. Advanced Individual Assessment of Cognitive Abilities.** Development of advanced understanding and skills in the use of clinical instruments for assessment of cognitive abilities. Analysis, interpretation, and consultation about individual assessment. Supervised experience involving collaboration with children, school personnel, parents, and clinic and community representatives. Prerequisites: Education 300, or equivalent, and consent of instructor. 3 units. *Davis* or *S. Gehman*

**302. Seminar in Educational Research.** The seminar is primarily for students working on dissertations and theses. Special topics are considered as appropriate to the research designs developed. Prerequisite: Education 260 or 261. 3 units. *Katzenmeyer*

**303. Diagnostic and Educational Programs in Learning Disabilities.** Diagnostic, intervention, and remediation strategies and program development for the child with learning disabilities; review of major works in this field. Prerequisite: consent of instructor. 3 units. *Davis* or *S. Gehman*

**304. Internship in School Psychology.** Supervised internship in school psychology, utilizing principles and practices in an approved internship site. (May be repeated.) Prerequisite: consent of instructor. 3 units. *Davis*

**309. Seminar on Higher Education in the United States.** Major trends, issues, problems, new developments, and future prospects for higher educational institutions (excluding the junior/community college) in the United States. 3 units. *Flowers*

**310. Seminar in Higher Educational Administration.** New developments in the organization and administration of higher educational institutions, with special attention to administrative and organizational systems, management information systems, managerial accountability, and strategies for continuous planning and institutional renewal. 3 units. *Hopkins*

**311. Group Counseling.** Theories and techniques of counseling for small groups of children, adolescents, teachers, parents, and other adults. Simulated practice through recorded interviews and transcribed counseling sessions. Prerequisites: Education 244 and Education 245. 3 units. *S. Gehman*

**313. Seminar in Education and Public Policy.** The relationship of educational administration to the public policy process. (Also listed as Political Science 313.) 3 units. *Leach* or *Pittillo*

**314. Seminar in Guidance and Counseling.** Research, writing, and reporting on selected problems in the field of guidance and counseling. 3 units. *Weitz*

**315. Seminar in Secondary School Teaching.** Advanced-level consideration of principles, practices, and problems in secondary school instruction. Designed particularly to accompany an internship. For students without previous internship credit, this course must be accompanied by Education 216. 3 units. *Carbone* or *Hurlburt*

**316, 317. Practicum in Higher Educational Research and Development.** Review of the purposes and essential stages of research and development in higher education, followed by individual projects covering problem-identification, literature searches related to the problem, development of product specifications and design, and pilot testing of prototype product. 3 units each semester. *Hopkins*



**321. Educational Management.** Theory and practice of management as applied to education. For anyone who has, or is preparing to have, major management responsibilities in the field of education. 3 units. *Pittillo*

**322. Planning and Management of Educational Facilities.** For teachers, administrators, and supervisors. 3 units. *Pittillo*

**323. Public School Finance.** Educational costs, sources of revenue for the support of public education, collection of revenue, basis of distribution, and accounting for funds spent. 3 units. *Pittillo*

**326. Educational Psychology: The Problem Child.** Problem behavior and adjustment in children with emphasis on the causes and treatment of conduct and neurotic disorders of the maladjusted child. Particular attention will be paid to mental hygiene principles in the handling of problem children in school and home. 3 units. *I. Gehman*

**332. Supervision of Instruction.** The nature of supervision, underlying principles, and techniques of working with individual teachers and with groups. 3 units. *Hurlburt*

**335, 336. Seminar in School Administration.** Organization and control over public education. First semester: attention to governance of education as exercised by the different branches and levels of government. Second semester: administrative organization. 3 units each semester. *Flowers, Hurlburt, Petty, or Pittillo*

**337. Seminar in Community College Organization.** The nature, function, and organization of community colleges. Research, writing, and reporting on selected problems. 3 units. *Hurlburt*

**338. Seminar in Educational Supervision.** Prerequisite: Education 332 or equivalent. 3 units. *Hurlburt*

**339. Seminar in Curriculum.** Research, writing, and reporting on selected problems. 3 units. *Cartwright*

**340. Seminar in Social Studies Curriculum.** Research, writing, and reporting on selected problems. 3 units. *Cartwright*

**341. Seminar in Elementary School Curriculum.** Research, writing, and reporting on selected problems. 3 units.

**342. Seminar in Secondary School Curriculum.** Research, writing, and reporting on selected problems. 3 units. *Cartwright*

**343. History of Higher Education in America.** The growth and development of higher education in the United States from 1636 to the present. Twentieth-century developments are stressed. 3 units. *Hopkins*

**344. Research in Higher Education.** Review of theory, practice, and contribution of research as an aid in understanding the functioning of institutions of higher education. 3 units. *Hopkins*

**345. Seminar in Reading Instruction and Research.** Major problem areas in contemporary reading instruction, with emphasis on theoretical, historical, and philosophical contributions to the formulation of objectives and methodologies in modern reading instruction. 3 units. *Adams*

**346. Seminar in Organization of Pre-Service and In-Service Reading Programs.** Theories, content, and instructional strategies for teaching reading and other language arts courses in university and in-service courses. 3 units. *Adams*

**347. Student Personnel Services in Higher Education.** Basic objectives of student personnel services in post-secondary education and the administrative procedures developed to achieve these objectives. 3 units. *Colver*

**348, 349. Seminar in Child Psychopathology.** Under the direction of a child psychiatrist, the student will select one elementary school aged child for a psychoanalytic study of neurotic conflicts, unconscious motivations, dream work, defense mechanisms, and transference phenomena. Prerequisite: consent of instructor. 3 units. *Fowler*

**350, 351. Directed Activities in Education.** Internship experiences at an advanced level under supervision of appropriate staff. Consent of instructor. 3 units each semester. *Staff*

**360. Seminar on Instructional Strategies.** Relationships among the broad purposes of education, the process and product objectives, and strategies employed to achieve those purposes and objectives. A synthesis among the purposes, objectives, and strategies is sought. 3 units. *Katzenmeyer*

## Engineering

Aleksandar Sedmak Vesić, D.Sc., Dean (136 Engineering)

The School of Engineering offers programs of study and research leading to the degrees of Master of Science and Doctor of Philosophy with a major in biomedical, civil, or electrical engineering, or in mechanical engineering and materials science. These programs are designed to provide a fundamental understanding of the engineering sciences, which are based on mathematics and the physical sciences, and to develop experience in the art of engineering, which includes strong elements of intuition, imagination, and judgment. Engineering graduate students may participate in seminars appropriate to their fields of study.

A *minimum* of 30 units of earned graduate credit beyond the bachelor's degree is required for the M.S. degree: 12 in the major, 6 in related minor work (usually mathematics or natural science), 6 in either the major or minor subject or in other areas approved by the major department, and 6 for a research-based thesis. A non-thesis option requiring 30 units of course credit is available. Each of the departments imposes additional requirements in the exercise of this option. There is no language requirement for this degree.

A *minimum* of 60 units of earned graduate credit beyond the bachelor's degree is required for the Ph.D. degree. In civil and electrical engineering, 24 units are required in the major field and 12 units in a related minor field (often mathematics or natural science), 12 in either the major or minor subject or other areas approved by the major department and 12 for a research-based dissertation. In biomedical and mechanical engineering there are no specific course requirements; each program is planned to meet individual needs. Doctoral students are required to pass qualifying and preliminary examinations which may be either written, oral, or a combination of written and oral components, at the discretion of the committee and the department.

## BIOMEDICAL ENGINEERING

Professor Pilkington, *Chairman*; Professor Thurstone, *Director of Graduate Studies*; Professors Clark, McElhaney, Nolte, Wolbarsht; Associate Professors Barr, Evans, Hammond, and Wachtel; Assistant Professors Tolley and von Ramm

Biomedical engineering is often defined as the application of the concepts and methods of the physical, mathematical, and engineering sciences to biology and

medicine. The definition covers a broad spectrum ranging from formalized mathematical theory through experimental science to practical clinical applications. The purpose of the graduate program in biomedical engineering is to encourage the optimum combining of engineering and biomedical course work with an interdisciplinary research topic so that the graduates of this program can contribute at the most advanced professional level to the interdisciplinary field of biomedical engineering. The major research areas available include: biomechanics, biomedical materials; biomedical modeling; data acquisition and processing; and electrophysiology.

**201. Analysis of Bioelectric Phenomena.** Fundamentals of bioelectric modeling with particular emphasis on neural and cardiovascular systems exhibiting phenomena varying from cellular to the whole organism level. 4 units. *Wachtel*

**202. Energy and Rate in Biological Processes.** An introduction to biomedical thermodynamics and transfer processes with particular emphasis on environmental studies, hyperbaric exposure, and the functions of natural and artificial organs. Not open to students who have had Biomedical Engineering 172. 3 units. *Clark*

**203. Bioelectric Potentials and Field Theory.** A study of bioelectric potentials and models for their generation. Analysis from a field theoretic point of view with particular emphasis on formulations that are amenable to computation. 3 units. *Pilkington*

**204. Real Time Measurement and Control of Heart Events.** Specification of procedures and devices from biological considerations, and their design and construction. Consideration of amplifiers, analog-digital conversion, computer interfaces, and associated programming. Evaluation of selected examples for accuracy, complexity, and cost. 3 units. *Barr*

**207. Experimental Mechanics.** Experimental studies and techniques basic to mechanics, stress-strain measurements and transducers, dynamic force, acceleration and flow measurements and analysis, viscoelastic behavior and modeling, high speed photographic methods, general applications to biomechanics including gait and analysis, head injury, automotive safety criteria, and blood flow. 3 units. *McElhaney*

**223. Biomedical Materials and Artificial Organs.** The use of artificial organs to replace or augment natural function in pumping and oxygenation of blood, removal of nitrogenous wastes and other toxins, and prostheses which have mechanical, chemical, or cosmetic function. Emphasis is placed on molecular architecture of materials for use in biological environment and optimization of parameters of materials which determine their utility in varying applications. 3 units. *Clark*

**225. Mechanics of Cellular Components.** Concepts of solid, semi-solid, and liquid mechanics applied to the study of cell components, e.g., membranes, cytoplasm, organelles, nuclei, etc. Transition from molecular structure to continuum properties will be emphasized. Prerequisite: consent of instructor. 3 units. *Evans*

**230. Biomechanics.** Kinematic models of human motions, mechanical properties of bone and soft tissues, hydrodynamics of micturition, load directed growth mechanisms, human tolerance to impact and vibration, head injury criteria applied to helmet design. Prerequisite: consent of instructor. 3 units. *McElhaney*

**233. Discrete Systems and Models of Computation.** Difference equations, numerical approximation, and digital filters with particular emphasis on developing constrained models that are both physically reasonable and amenable to computation. 3 units. *Pilkington*

**241, 242. Information Organization and Retrieval.** (Also listed as Computer Science 241, 242.) 6 units. *Hammond*

**243. Computers in Biomedical Engineering.** An in-depth study of the use of computers in biomedical applications. Hardware, software, and applications programming will be considered. Data collection, analysis, and presentation will be studied within application areas such as monitoring, medical records, computer-aided diagnoses, computer-aided instruction, MD-assistance programs, laboratory processing, wave form analysis, hospital information systems, and medical information systems. 3 units. *Hammond*

**252. Marine Electrobiolgy.** The physiology and behavioral consequences of bioelectric activity, ranging from the cell membrane to the interanimal communication level. Laboratory work deals with bioelectric recording and stimulation techniques with particular emphasis placed on electrophysiological studies of marine organisms wherein cellular correlates of animal behavior are clearly seen. Ionic basis of bioelectric signals, transmission of signals within and between cells, relation of bioelectric signals to particular behavioral patterns, effects of externally applied electric fields, bioelectric communication and navigation systems. Prerequisite: consent of instructor. Summer at Beaufort. (Also listed as Physiology and Pharmacology 222.) 6 units. *Wachtel and Wolbarsht*

**265. Advanced Topics in Biomedical Engineering.** Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a small group. Prerequisites: consent of chairman and instructor under whom the work will be done. 1 to 4 units. *Staff*

**311. Inverse Models.** Analytical and computational methods for determining the internal state of a biological system from a set of external measurements and a *priori* characterization of the system. Particular emphasis is placed on the inherent limitations and difficulties encountered in obtaining numerical solutions from inverse formulations and the value of constraints in reducing these difficulties. 3 units. *Pilkington*

**333. Biomedical Imaging.** A study of the fundamentals of information detection, processing, and presentation associated with imaging in biology and medicine. Analysis of coherent and incoherent radiation and various image generation techniques. Also covered will be the psychometrics of image evaluation dealing with subjective and objective parameters. Emphasis will be placed upon sonography, thermography, X-ray, various forms of nuclear radiography, microscopy, and holography. 3 units. *Thurstone*

**399. Special Readings in Biomedical Engineering.** Individual readings in advanced study and research areas of biomedical engineering. Prerequisite: approval of the Director of Graduate Studies. 1 to 3 units each semester. *Graduate Staff*

## CIVIL ENGINEERING

Professor Muga, *Chairman* (121 Engineering); Professor Dvorak, *Director of Graduate Studies* (126 Engineering); Professors Brown, Utku, and Vesić; Associate Professors Palmer, Vesilind, and J. F. Wilson; Assistant Professors Medina and Tsui; Adjunct Professor Saibel; Adjunct Assistant Professor Warner; Lecturers Francisco, Gilbert, Lathrop, and Rimer

A student may specialize in one of the following fields of study for either the M.S. or the Ph.D. degree: environmental engineering; geotechnical engineering and soil mechanics; mechanics of solids; materials engineering; fluid mechanics, water resources, and ocean engineering; structural engineering; and urban systems and



transportation. Interdisciplinary programs combining study in some of the major areas with biological sciences, business administration, materials science, social sciences, political science, and other areas of engineering are also available. In addition, there is a special program leading to the M.S. degree in civil engineering and the A.M. degree in public policy sciences.

With the approval of the department, a master's degree candidate in civil engineering may choose, in lieu of submitting a thesis, to complete an additional 6 units of course work plus a special project. If this alternative is elected, candidates are expected to take comprehensive examinations over their graduate course work, and also to defend orally their special projects.

Under the Reciprocal Agreement with Neighboring Universities, a student may include as a portion of the minimum requirements work offered by the Department of Environmental Sciences and Engineering of the University of North Carolina. Although related work normally is taken in the natural sciences or mathematics, a student whose major interest relates to the social or managerial sciences may take relevant work in these areas.

A minimum prerequisite to the graduate program in civil engineering is a basic knowledge of mathematics through linear differential equations, materials science, solid mechanics, and fluid mechanics.

**201. Advanced Mechanics of Solids.** Cartesian tensors, dyadics, and matrices. Analysis of states of stress and strain. Conservation laws and field equations. Constitutive equations for elastic, viscoelastic, and elastic-plastic solids. Formulation and solution of simple problems in elasticity, viscoelasticity, and plasticity. Corequisite: Mathematics 285 or equivalent. 3 units. *Dvorak*

**204. Plates and Shells.** Differential equation and extremum formulations of linear equilibrium problems of Kirchhoffian and non-Kirchhoffian plates of isotropic and orthotropic material. Solution methods. Differential equation formulation of thin shell problems in curvilinear coordinates; membrane and bending theories; specialization for shallow shells, shells of revolution, and plates. Extremum formulation of shell problems. Solution methods. Prerequisites: Mathematics 104, and Engineering 75 or Engineering 135, or consent of instructor. 3 units. *Utku*

**205. Elasticity.** Introduction to linear theory of elasticity. Constitutive equations for anisotropic and isotropic elastic solids. Formulation and solution of torsion, bending, and plane problems by semi-inverse, complex potential, and variational methods. Three-dimensional problems. Prerequisite: Civil Engineering 201 or equivalent. 3 units. *Dvorak*

**206. Advanced Mechanics of Solids II.** Continuum theories for time-independent and time-dependent materials. Formulation and solution of boundary value problems; analytical and numerical techniques, applications. Prerequisite: Engineering 135 or Civil Engineering 201. 3 units. *Dvorak*

**209. Structural Dynamics.** Vibration and stability (small and global) of discrete and continuous linear systems; introduction to nonlinear theory, parametric and random excitation. Applications include response studies of machines, ships, pipelines, bridges, and buildings to man-made and nature-induced loadings. (Also listed as Mechanical Engineering 209.) 3 units. *J. F. Wilson*

**210. Intermediate Dynamics.** (Also listed as Mechanical Engineering 210.) 3 units. *Macduff or J. F. Wilson*

**212. Mechanical Behavior of Materials.** Mechanical behavior and its relationship to microstructural deformation and fracture processes in polycrystalline, polymeric, and composite materials. Influence of temperature, strain rate, and envi-

ronmental conditions on material behavior. Fracture mechanics and its application to brittle and ductile fracture, and fatigue in structural metals, polymers, composites, and concrete. Prerequisite: Civil Engineering 201. 3 units. *Dvorak*

**215. Urban and Regional Geography.** Human settlements and locational patterns. Location theory and land-use systems. Normative and descriptive location decisions. Location and impact of constructed facilities. Spatial interaction and network structure. Geography of transportation and environmental quality. 3 units. *Staff*

**216. Transportation Planning and Policy Analysis.** Issues in policy planning and decision-making in urban and rural transportation systems. Transportation legislation. Public transportation alternatives with emphasis on public transit and paratransit solutions. Prerequisite or corequisite: Civil Engineering 116 or consent of instructor. (Also listed as Public Policy Sciences 254.) 3 units. *Lathrop*

**217. Transportation Systems Analysis.** The transportation systems planning process. Quantitative analysis, mathematical modeling and computer simulation techniques for short- and long-range planning and evaluation of transportation systems. Prerequisite or corequisite: Civil Engineering 116 or consent of instructor. 3 units. *Warner*

**218. Engineering-Economic Analysis.** Methods of analysis applicable to the economic evaluation of both pre-construction project plans and post-construction project outcomes. Principles of engineering economics with regard to time dependent costs and benefits. Techniques of economic evaluation and comparisons of multiple alternatives. Concepts of welfare economics with regard to public works development. Identification and measurements of both monetary and non-monetary consequences of public works. Student projects involving the analysis and evaluation of public investments. 3 units. *Warner*

**221. Incompressible Fluid Flow.** Steady and unsteady pipe flow; theories of turbulent flow; water hammer theory and control; surge tanks; air chambers; the analysis and control of fluid systems; effect of resistance; tapered conductors. 3 units. *Muga*

**222. Open Channel Flow.** Basic principles. Selected flow problems and practical solutions; gutter and inlet flows, flow over spillways, flow into estuaries and bays. Design of open channel structures, river hydraulics. Design of flood control and navigation structures; culverts, bridge openings, and energy dissipators. 3 units. *Muga*

**223. Flow Through Porous Media.** Theory of miscible and immiscible fluid displacement processes. Derivation and solution methods. Selected problems in stability, fingering, and capillarity. Applications; saline water intrusion, secondary recovery processes, seepage through earthen dams, dewatering of construction sites, and well point operation. 3 units. *Muga*

**224. Coastal and Offshore Engineering.** Basic analytical concepts; wave phenomena, theory of surface water wave motion, wave modification, and wave spectra. Effects of waves on structures emphasizing design of marine facilities and other selected problems. 3 units. *Muga*

**225. Engineering Hydrology.** Study of processes governing the origin, distribution, and depletion and replenishment of water resources, and application of this knowledge to the solution of water supply and drainage problems. Topics include the hydrologic cycle, hydrometeorology, precipitation runoff, hydrograph analysis, evapotranspiration, infiltration, groundwater, runoff, stream flow, groundwater recharge, and hydrologic measurements. 3 units. *Medina or Muga*

**231. Structural Engineering Analysis.** The analysis of fundamental structural forms including arches, suspension cables and members of variable inertia. Influence lines for indeterminate structures. Introduction to matrix analysis. Prerequisites: Civil Engineering 131 and Mathematics 104, or consent of instructor. 3 units. *Brown*

**232. Reinforced Concrete Design.** A critical review of research related to the development of existing codes. Special attention is given to the consideration of temperature change effects, shrinkage, plastic flow, bond, and shear and diagonal tension. Two-way slab and flat plate design. Prerequisite: Civil Engineering 133. 3 units. *Brown*

**233. Prestressed Concrete Design.** A critical review of research and recent developments in prestressed concrete design. Prestressed tanks, beams, and columns; partial prestressing and composite design. Prerequisite: Civil Engineering 133. 3 units. *Brown*

**234. Structural Design in Metals.** Design of metal structures using both elastic and plastic theories. Application to plate girders, bridge trusses, and building frames. Interpretation and justification of building codes and specifications. Planning, preliminary design, and organization of design procedures. Prerequisite: Civil Engineering 134. 3 units. *Palmer*

**235. Foundation Engineering.** An introduction to methods of analysis, design, and construction of foundations. Bearing capacity and settlement of shallow and deep foundations. Soil exploration; excavation and bracing; drainage and stabilization; and underpinning. Foundation vibrations. 3 units. *Vesic*

**236. Earth Structures.** An introduction to methods of analysis, design, and construction of earth structures such as dams, embankments, cuts, canals, and air-field and highway pavements. Selection of materials, soil compaction, and stabilization. Theory of seepage, design of wells and drainage collectors. Slope stability and related problems. Theory of layered systems and pavement design procedures. 3 units. *Tsui*

**238. Rock Mechanics.** Behavior and properties of rock as an engineering material; failure of rock. Design and construction of underground structures and slopes in rock; design of rock abutments for dams. Laboratory and field rock testing techniques. Prerequisite: Civil Engineering 139 or consent of instructor. 3 units. *Tsui*

**241. Environmental Engineering Chemistry and Biology.** Inorganic and organic chemistry as applied to water and wastewater treatment. Chemical equilibria and kinetics. Population dynamics and energy transfer in metabolic systems. Instrumental analysis, including spectrophotometry, chromatography, and atomic adsorption. Atmospheric chemistry and analytical methods. Prerequisite: Civil Engineering 124. 3 units. *Francisco*

**243, 244. Sanitary Engineering Unit Operations and Process Design.** Fundamental bases for design of water and waste treatment systems, including transport, mixing, sedimentation and filtration, gas transfer, coagulation, and biotreatment processes. Prerequisite: Civil Engineering 124 or consent of instructor. 6 units. *Vesilind*

**246. Sanitary Engineering Design.** The study of water resources and municipal water requirements including reservoirs, transmission, treatment and distribution systems; methods of collection, treatment and disposal of municipal and industrial wastewaters. The course includes the preparation of a comprehensive engineering report encompassing all aspects of municipal water and wastewater



systems. Field trips to be arranged. Prerequisite: Civil Engineering 124 or consent of instructor. 3 units. *Rimer and Vesilind*

**247. Air Pollution Control.** The problem of air pollution, with reference to chemical and biological effects. Measurement and meteorology of air pollution. Air pollution control methods. Noise pollution, odor, and air pollution law. 3 units. *Vesilind*

**248. Solid Waste and Resource Recovery Engineering.** Engineering design of resource recovery systems including traditional and advanced technologies. Sanitary landfills and incineration of solid wastes. Energy recovery and recycling municipal refuse. Collection, treatment, and disposal of solid wastes from wastewater treatment. Prerequisite: Civil Engineering 124 or consent of instructor. 3 units. *Rimer and Vesilind*

**249. Resource Recovery Systems Management.** The social, economic, legal, political, and administrative aspects of resource recovery from municipal solid wastes. Economic applications and systems management. Assessment methodologies. Federal and state legislation. Public versus private sector interests. Policy issues. Case studies. Prerequisite: consent of instructor. 3 units. *Warner*

**250. Engineering Analysis.** Formulation of mathematical models selected from a wide variety of engineering disciplines; optimization; use of infinite series, finite difference calculus, energy methods, and digital computers as problem-solving techniques. 3 units. *J. F. Wilson*

**251. Systematic Structural Analysis I.** Computer analysis techniques for the equilibrium problems of solids and structures. Describing the problems to a digital computer. Transformation matrices. Recapitulation of energy theorems. Stiffness and flexibility relations of structural elements in discrete space and continuum. Systematic analysis of equilibrium problems by displacement and force methods. Errors. Prerequisites: Mathematics 104, and Civil Engineering 131 or Engineering 135, or consent of instructor. 3 units. *Utku*

**252. Systematic Structural Analysis II.** Computer analysis techniques for the equilibrium, eigenvalue, and propagation problems of solids and structures. Representation of initial stresses. Handling of geometrical nonlinearities in equilibrium problems. Buckling. Handling of material nonlinearities. Incremental load techniques. Time dependent materials. Representation of inertial and damping forces. Stationary and transient vibrations. Random vibrations. Prerequisite: Civil Engineering 251 or consent of instructor. 3 units. *Utku*

**306. Plasticity.** Mathematical theories of time-independent inelastic material behavior and their experimental foundations. Yield conditions, flow and hardening rules, unloading, shakedown. Theories of limit analysis. Slipline fields. Numerical methods. Applications to problems in the design of structures, metal forming, stress analysis in metals and composites, and in fracture mechanics. Prerequisite: Civil Engineering 205. 3 units. *Dvorak*

**331. Special Problems of Systematic Analysis.** Roundoff and truncation errors. Bounds for approximate solutions. Higher order representations and their advantages and disadvantages. Connectivity matrices and systematic substructuring. Improved algorithms for linear equation solution and eigenvalue extraction. Prerequisite: Civil Engineering 252 or consent of instructor. 3 units. *Utku*

**335. Mechanical Behavior of Soils.** Origin of soils, soil minerals, and processes of soil formation; physical chemistry of multiphase systems and soil structure. Permeability and flow of water through soils: capillary and osmotic phenomena:



soil compressibility; theory of consolidation; shear strength and failure criteria. Stress-strain relationships, volume changes, and pore pressure during shear strength properties. Advanced laboratory soil testing techniques. 4 units. *Vesić*

**336. Advanced Soil Mechanics.** Theories of plastic and elastic equilibrium of soil masses and their application to analysis of problems such as pressure on retaining walls, anchored bulkheads, cofferdams, silos, shafts, and tunnels; stability of slopes; stresses and settlement in soil masses and pavement; piles and pile groups subjected to lateral loads. Prerequisite: Civil Engineering 335. 4 units. *Vesić*

**337. Elements of Soil Dynamics.** Behavior of soils and foundations under transient and impact loads. Mechanics of pile driving. Foundation vibrations. Effects of explosions on soils: wave propagation, cratering. Earthquake effects on foundations, earth dams, and slopes. Compaction of loose soils by explosives or by vibration. Behavior of layered systems under dynamic loads. Prerequisite: Civil Engineering 335 or consent of instructor. 3 units. *Vesić*

**350. Advanced Engineering Analysis.** Review of general mathematical properties of boundary value, eigenvalue, and initial value problems in continuum. Alternate equivalent formulations. Comparative survey of approximate methods for reducing continuum problems into equivalent discrete problems for numerical solutions. Prerequisites: Computer Science 221 and 222, or consent of instructor. 3 units. *Utku*

**365. Advanced Topics in Civil Engineering.** Opportunity for study of advanced subjects relating to programs within the Civil Engineering Department tailored to fit the requirements of a small group. 1 to 3 units. *Graduate Staff*

**399. Special Readings in Civil Engineering.** Special individual readings in a specific area of study in civil engineering. Prerequisite: approval of the Director of Graduate Studies. 1 to 3 units. *Graduate Staff*

## ELECTRICAL ENGINEERING

Associate Professor H. Hacker, Jr., *Chairman* (130 Engineering); Professor Marinos, *Director of Graduate Studies* (173 Engineering); Professors Artley, Kerr, Nolte, Owen, Pilkington, Thurstone, Wang, and Wilson; Associate Professor Joines; Assistant Professors George and Shubert

A student may specialize in any one of the following fields in working toward either the M.S. or the Ph.D. degree with a major in electrical engineering: solid state materials and devices; ferromagnetics; optical electronics and lasers; instrumentation; electronic systems; microwaves; control theory; energy conversion; digital systems; stochastic systems; and information processing.

Recommended prerequisites for the graduate courses in electrical engineering include a knowledge of basic mathematics and physics, electric networks, and systems theory. Students in doubt about their background for enrollment in specific courses should discuss the matter with the Director of Graduate Studies. The M.S. degree program includes either a thesis or an oral comprehensive examination. A qualifying examination is required for the Ph.D. degree program. These examinations are intended to test both the breadth and depth of the student's understanding of electrical engineering. There is no foreign language requirement.

**203. Random Signals and Noise.** Introduction to mathematical methods of describing and analyzing random signals and noise. Review of basic probability theory; joint, conditional, and marginal distributions; random processes. Time and ensemble averages, correlation, and power spectra. Optimum linear smoothing and

predicting filters. Introduction to optimum signal detection and parameter estimation. Fall semester. (Also listed as Computer Science 203.) 3 units. *Kerr or Nolte*

**204. Information Theory and Communication Systems.** Information and entropy and their application in communication situations. Noise and channel capacity, coding, and the fundamental theorem of information theory. Continuous channels and transmission of band-limited signals. Comparisons of various practical modulation techniques from the standpoint of information rate and error probability. Spring semesters, 1978, 1980. Prerequisite: Electrical Engineering 203. 3 units. *Marinos or Nolte*

**205. Signal Detection and Extraction Theory.** Introduction to signal detection and information extraction theory from a statistical decision theory viewpoint. Subject areas covered within the context of a digital environment are decision theory, detection and estimation of known and random signals in noise, estimation of parameters and adaptive recursive digital filtering, and decision processes with finite memory. Applications to problems in communication theory. Spring semester. (Also listed as Computer Science 205.) Prerequisite: Electrical Engineering 203 or consent of instructor. 3 units. *Nolte*

**206. Digital Signal Processing.** Introduction to the fundamentals of processing signals by digital techniques with applications to practical problems. Discrete time signals and systems, elements of the z-transform, discrete Fourier transform, digital filter design techniques, fast Fourier transform, and discrete random signals. Fall semester. 3 units. *Nolte*

**208. Digital Computer Design.** Hardware implementation of combinational and sequential switching networks. Arithmetic elements, switching matrices, character generators, counters, and microprocessors. Detailed design and simulation of a general-purpose computer system. Computer architectures based on macromodules, hardware compiler implementations, and parallel processing concepts are also discussed. Prerequisite: Electrical Engineering 157 or consent of instructor. Spring semester. (Also listed as Computer Science 208.) 3 units. *Marinos or Owen*

**211. Solid State Theory.** A treatment of postulatory quantum mechanics and statistical mechanics to serve as a background for the solid state sciences. Topics include both the Schrodinger and matrix formulations, angular momentum, perturbation methods, Maxwell-Boltzmann and Fermi distributions. Prerequisite: consent of instructor. Fall semester. 3 units. *Artley or Hacker*

**212. Solid State Materials.** Concepts of solid state physics as applied to engineering materials; electric magnetic, thermal, and mechanical properties of solids; dielectrics; semiconductors; magnetic materials; superconductors. Prerequisite: Electrical Engineering 211. Spring semester. 3 units. *Artley or Hacker*

**213. Principles of Magnetism.** A discussion of the various classes of magnetic materials including diamagnets, paramagnets, ferromagnets, antiferromagnets, and ferrimagnets. Typical topics include: crystal field effects, exchange interactions, domain formation, and resonance phenomena. Prerequisite: consent of instructor. 3 units. *Artley or Hacker*

**215. Semiconductor Physics.** A quantitative treatment of the physical processes that underlie semiconductor device operation. Topics include: band theory and conduction phenomena; equilibrium and nonequilibrium charge carrier distributions; charge generation, injection, and recombination; drift and diffusion processes. Prerequisite: Electrical Engineering 211 or consent of instructor. 3 units. *Hacker*

**217. Masers.** Principles of masers, particularly optical masers. Discussion of quantum electronics; optical configuration; solid state, gaseous, and liquid devices; modulation; high power operation. Some laboratory work. Prerequisite: consent of instructor. Spring semesters, 1977, 1979. 3 units. *George or Shubert*

**221. Nonlinear Networks and Systems.** Characterization of nonlinear multi-terminal network elements, formulation of system equations from topological and energy considerations. Basic properties and general methods of solution of resistive nonlinear networks. Time-varying linear systems. Examination of some fundamental properties of nonlinear differential equations. Spring semester. 3 units. *Wilson*

**222. Nonlinear Analysis.** Introduction to methods of analyzing engineering systems described by nonlinear differential equations: analytic, numerical, graphical, and series approximation methods; analysis of singular points; stability of nonlinear systems. Applications of various methods, such as the modified Euler, Runge-Kutta, isoclines, perturbation, reversion, variation of parameters, residuals, harmonic balance, Bendixon, and Liapounov to phenomena of nonlinear resonance, subharmonics, relaxation oscillations, and forced oscillating systems. Fall semester. (Also listed as Mechanical Engineering 232.) 3 units. *Wilson*

**224. Integrated Electronics: Analog and Digital.** Application of integrated circuits for analog and digital systems. Topics include the effect of fabrication techniques on circuitry design, a study of differential and operational amplifiers, and consideration of various logic families such as resistor-transistor logic (RTL), diode-transistor logic (DTL), current-mode or emitter-coupled logic (ECL), and transistor-transistor logic (TTL). Prerequisite: Electrical Engineering 161 or equivalent. Fall semester. 3 units. *Wilson*

**225. Semiconductor Electronic Circuits.** Analysis and design of electronic circuits utilizing a variety of static and dynamic models of semiconductor devices. Transistor and other semiconductor device circuit models; bias stability; high frequency and noise models; switching characteristics; illustrative semiconductor circuits. Selected laboratory work. Spring semester. Prerequisite: consent of instructor. 3 units. *Joines or Shubert*

**226. Modeling and Computer-Aided Analysis of Electronic Systems.** Modeling of linear and nonlinear components and devices. Network topology, including nodal and state variable formulations. Sparse matrix techniques for nodal formulations; explicit and implicit integration techniques for state variable formulations. Algorithms for computer-aided analysis. Selected projects. Prerequisite: Electrical Engineering 103 or 161, or equivalent. Spring semester. 3 units. *Owen*

**227. Network Synthesis.** Linear network theory, including a review of time and frequency domain analysis; network graphs; network functions and realizability condition; driving point impedance synthesis of passive networks; driving point and transfer specifications; approximation methods. Fall semester, 1977. Prerequisite: consent of instructor. 3 units. *George*

**231. Energy Systems.** A comprehensive treatment of the general concepts of storage, transfer, transformation, and control that are applicable to a variety of technical systems with emphasis on their common mathematical structure. Attention is given to the human use of energy for personal, industrial, and commercial purposes. Economic and social factors as well as scientific factors are considered. Fall semester. 3 units. *Artley*

**241. Linear Systems.** Modeling of multiple input-output linear systems in the frequency and time domains. Matrix differential and difference equations and their solutions; state variables. Digital simulation of differential systems. Fourier



analysis of signals and systems. Transform techniques applied to state variable models. State space models of distributed systems. Fall semester. 3 units. *Kerr or Wang*

**242. Modern Control and Dynamic Systems.** See course description for Mechanical Engineering 230. (Also listed as Mechanical Engineering 230.) 3 units. *Wright*

**243. Advanced Linear Systems Theory.** Linear spaces and linear operators. Impulse-response matrices. Controllability and observability. Irreducible realizations of rational transfer function matrices. Canonical forms, state estimators, and observer theory. Stability. Linear time-invariant composite systems. Prerequisite: Electrical Engineering 241. Spring semesters, 1978, 1980. 3 units. *Kerr or Wang*

**251. Pattern Classification and Recognition.** Parameter estimation and supervised learning; nonparametric techniques; linear discriminant functions; clustering; language theory related to pattern recognition and syntactic pattern recognition; examples such as characters, severe weather recognition and classification of community health data, etc., are discussed. Prerequisite: consent of instructor. Spring semesters, 1978, 1980. 3 units. *Wang*

**265. Advanced Topics in Electrical Engineering.** Opportunity for study of advanced subjects related to programs within the Electrical Engineering Department tailored to fit the requirements of a small group. Prerequisites: approval of the Director of Graduate Studies and of instructor under whom work will be done. 1 to 3 units. *Staff*

**266. Biofeedback Systems.** Instrumentation, on-line computer analysis, and models associated with biofeedback systems. Selected readings will be considered in conjunction with experience in laboratory feedback practices. The physical, physiological, and psychological aspects of biofeedback provide a vehicle for experiential learning which relates individual experience to models used in systems theory, field theory, electronics, and communications. Prerequisite: consent of instructor. Spring semester. 3 units. *Artley*

**271. Electromagnetic Theory.** The classical theory of Maxwell's equations; electrostatics, magnetostatics, boundary value problems including numerical solutions, currents and their interactions, and force and energy relations. Three class sessions. Fall semester. Prerequisite: consent of instructor. 3 units. *Hacker or Joines*

**272. Application of Electromagnetic Theory.** Propagation of electromagnetic waves in various structures and media; mathematical description of microwave networks, including equivalent circuits and matrix methods; microwave circuit theorems and synthesis techniques. Selected laboratory experiments. Spring semesters, 1978, 1980. Prerequisite: Electrical Engineering 271. 3 units. *Joines*

**297-298. Thesis Research.** 6 units.

**304. Estimation, Filtering, and Random Systems.** Statistical estimation and filtering techniques applied to signal analysis and system identification. Weiner and Kalman filter theory in the estimation of system state variables and system parameters. Statistical treatment of linear random operators and random differential equations. Applications to communications and control with selected computer exercises. Prerequisite: Electrical Engineering 203. Spring semester. 3 units. *Kerr*

**305. Advanced Applications of Statistical Decision Theory.** Optimum modulators and demodulators, comparison of various systems. Gaussian signals in Gaussian noise; sonar-radar problem, representation of narrow band processes, slowly fluctuating targets, optimum receiver for estimating range and Doppler, properties



of autocorrelation functions and ambiguity functions, pseudo-random signals, resolution, frequency spreading, reverberation, active sonar, optimum space-time system, and passive sonar. Prerequisite: Electrical Engineering 205. Fall semesters, 1978, 1980. 3 units. *Nolte*

**306. Adaptive Detection and Communication Systems.** Sequential detection, Wald's sequential probability ratio test, sequential tests of composite hypotheses, deferred decision theory; adaptive systems, nondecision directed and decision-directed measurements, adaptive on-off communications systems, transmitted reference systems, detection systems employing the learning feature, learning with and without a teacher, pattern recognition. Applications to communication systems. Prerequisite: Electrical Engineering 205. Fall semesters, 1977, 1979. 3 units. *Nolte*

**307. Advanced Digital Systems I.** A unified treatment of discrete computational structures. Mathematical foundations of discrete parameter systems: semi-groups, groups, rings, and fields. Sequential machines and their structure. Modular sequential structures. Elements of language theory. Physical design problems. Prerequisite: Electrical Engineering 157 or consent of instructor. Fall semester. (Also listed as Computer Science 307.) 3 units. *Marinos*

**308. Advanced Digital Systems II.** A unified treatment of parallel computational structures. Petri nets, flow-graph schemata, parallel computational schemata (PCS), and other models of parallel computations. Actual realizations of parallel computational schemata are presented. Prerequisite: Electrical Engineering 157 or consent of instructor. Spring semester. (Also listed as Computer Science 308.) 3 units. *Marinos*

**313. Magnetic Processes in Materials.\*** Selected topics in magnetism. Cryo-magnetics, spin wave resonance, interaction of superconductor and ferromagnetic materials, nonlinear spin wave theory, effects of finite dimensions and interfaces on basic properties of ferromagnets. Microwave applications. Prerequisite: Electrical Engineering 213 or consent of instructor. 3 units. *Hacker*

**317. Quantum Electronics.** Principles of optical fields and light-matter interactions concerned with the generation, propagation, detection, modulation, and control of optical radiation in atomic systems. Topics include optical Gaussian beams and guided-wave propagation, important optical and laser media, the electro-optic effect, the photo-elastic effect, nonlinear optics theory, parametric oscillation, Bragg and Brillouin scattering, dielectric optical waveguides and associated phenomena. Prerequisites: Electrical Engineering 211 and 271, or consent of instructor. Spring semesters, 1977, 1979. 3 units. *Shubert*

**321. Nonlinear Magnetic and Semiconductor Circuits.** Mathematical description of nonlinear magnetic and semiconductor characteristics; transient and steady-state analysis and synthesis of nonlinear systems with application of such topics as magnetic amplifiers, frequency converters, oscillators, computer logic, switching devices, and inverters. Prerequisite: consent of instructor. Spring semesters, 1977, 1979. 3 units. *Wilson*

**324. Nonlinear Oscillations in Physical Systems.** Analysis of phenomena encountered in free and forced oscillating systems: stability criteria, topological methods, degenerate systems and discontinuous theories, relaxation oscillations, asymptotic approaches. Emphasis on interdependence of physical and mathematical reasoning in analyzing nonlinear electrical and mechanical systems. Illustrative examples selected to meet interests of class. Prerequisite: Electrical Engineering 222. Spring semesters, 1978, 1980. 3 units. *Wilson*

**342. Optimal Control Theory.** Optimization problems for dynamic systems. Optimal feedback control. Linear systems with quadratic criteria; mathematical programming; optimal filtering and prediction; optimal feedback control in the presence of uncertainty. Prerequisite: Electrical Engineering 241. Spring semesters, 1977, 1979. 3 units. *Wang*

**371. Advanced Electromagnetic Theory.\*** An advanced treatment of topics in electromagnetic theory selected from the interests of the instructor and students. Representative topics are propagation in anisotropic media, plasma waves, antennas, and boundary value problems. Prerequisite: Electrical Engineering 272. 3 units. *Joines or Hacker*

**373. Selected Topics in Field Theory.\*** An advanced treatment of topics in generalized field theory selected from the interests of the instructor and the students. Representative topics are generalized fields, electromagnetic interactions, quantum electrodynamics, inhomogeneous media, and diffusion phenomena. Prerequisite: Electrical Engineering 272. 3 units. *Artley or George*

**399. Special Readings in Electrical Engineering.** Special individual readings in a specified area of study in electrical engineering. Prerequisite: approval of the Director of Graduate Studies. 1 to 3 units. *Graduate Staff*

## MECHANICAL ENGINEERING AND MATERIALS SCIENCE

Professor Chaddock, *Chairman* (142 Engineering); Assistant Professor Buzzard, *Director of Graduate Studies* (227 Engineering); Professors Clark, Cocks, Garg, Harman, Macduff, and Pearsall; Adjunct Professor Roberts; Associate Professors Elsevier, Shepard, and Wright; Adjunct Associate Professor Mayer; Assistant Professors Johnson and Shaughnessy

Graduate study is available to students seeking the M.S. and Ph.D. degrees with a major in either mechanical engineering or materials science. Departmental programs of advanced study and research include control systems, dynamics and vibrations, energy conversion, fluid mechanics, heat and mass transport, mechanical design, thermodynamics, physical metallurgy, corrosion, fracture, and polymer science. The faculty cooperates with faculty members from a number of other departments and schools to establish interdisciplinary research projects and programs of study in areas which include applied mechanics, biomechanics, biomedical materials, environmental quality and control, interaction of fields and materials, ocean engineering, systems engineering, engineering and public policy, and transportation systems.

The program includes the opportunity for experimental work as well as theoretical study. A major emphasis is placed upon developing the research ability of the student and relating the program to the evolving needs of modern engineering practice.

**202. Engineering Thermodynamics.** Review of classical thermodynamics. Thermodynamics of continuum properties of real substances. Analysis of energy conversion with internal irreversibility and advanced engineering problems. Introduction to the statistical basis of thermodynamics. 3 units. *Harman*

**209. Structural Dynamics.** (Also listed as Civil Engineering 209.) 3 units. *J. F. Wilson*

**210. Intermediate Dynamics.** Comprehensive treatment of space kinematics,

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\*Offered on demand.

kinetics of particles and rigid bodies; generalized coordinates and Lagrange's equations; introduction to stability and random dynamic analysis of flexible, continuous systems. (Also listed as Civil Engineering 210.) 3 units. *Macduff or J. F. Wilson*

**211. Theoretical and Applied Polymer Science.** An advanced course in materials science and engineering, dealing specifically with the structure and properties of polymers. Particular attention is paid to recent developments in the processing and use of modern plastics and fibers. Product design is considered in terms of polymer structures, processing techniques, and properties. 3 units. *Clark or Pearsall*

**213. Advanced Materials Science.** An in-depth study of current problems in materials applications conducted in a seminar format. Treatment will include thermal, electrical, optical, and magnetic properties of materials in terms of basic physical concepts. Subjects intended to provide materials scientists and engineers with a theoretical basis for understanding and manipulating properties. Prerequisites: Engineering 83 and Mechanical Engineering 111 or 112. 3 units. *Cocks, Pearsall, or Shepard*

**214. Corrosion and Corrosion Control.** Effects of environments on the design and utilization of modern engineering alloys. Theory and mechanisms of corrosion, particularly in seawater and atmospheric environments. Microstructural aspects of diffusion, oxidation, hot corrosion, and stress corrosion. Prerequisite: Engineering 83. 3 units. *Cocks or Shepard*

**216. Materials Design and Resource Conservation.** The role of materials science and engineering in the field of resource conservation and recovery. Selection of materials for components of consumer products and equipment. Designing materials at atomic, molecular, and phase-structure levels to minimize energy consumption, optimize properties, and enhance recycling. Analysis of some constraints posed by thermodynamics, economics, raw material availability, and governmental policies. Prerequisite: Engineering 83. 3 units. *Pearsall*

**221. Compressible Fluid Flow.** Basic concepts of the flow of gases from the subsonic to the hypersonic regime. Effects of friction, heat transfer, and shock on one-dimensional inviscid flow. Potential theory, oblique shock waves, and special calculation techniques in two-dimensional flow. 3 units. *Buzzard or Shaughnessy*

**222. Heat Transfer.** Steady-state and transient solutions of the general heat conduction equation. Development of the equations for transport of energy by fluid motion. Principle of similarity and dimensional analysis in convective energy transport. Solutions of the boundary layer equations. The laws of radiation heat transfer and radiation heat exchange. 3 units. *Chaddock or Buzzard*

**223. Principles and Design of Heat Transfer Equipment.** Application of theoretical and experimental developments in heat transfer to the design of heat exchangers. Study of fin shapes, finned passages, fouling factors, baffling and other parameters of heat exchanger design. Analytical and numerical methods for design calculation illustrated with equipment such as: furnaces, recuperators, regenerators, solar collectors, condensers, and evaporators. Prerequisite: Mechanical Engineering 150. 3 units. *Chaddock and Johnson*

**224. An Introduction to Turbulence.** Flow instability and the transition to turbulence. Physical characteristics of turbulent flows, averaging, and the Reynolds equation. Turbulent transport and mixing length theories. The statistical description of turbulence, correlations, and spectra. Fourier transforms. Measurement techniques. 3 units. *Shaughnessy*

**226. Intermediate Fluid Mechanics.** A survey of the principal concepts and



equations of fluid mechanics. Fluid properties. Statics. Basic equations for the control volume. The differential equations of fluid motion. Stream function. Irrotational flow. Navier-Stokes equations. Kelvin's and Crocco's theorem. Applications to two-dimensional incompressible potential flow and to viscous flow in boundary layers. 3 units. *Shaughnessy*

**230. Modern Control and Dynamic Systems.** Dynamic modeling of complex linear and nonlinear physical systems involving the storage and transfer of matter and energy. Unified treatment of active and passive mechanical, electrical, and fluid systems. State space formulation of physical systems. Time and frequency-domain representation. Controllability and observability concepts. System response using analytical and computational techniques. Lyapunov method for system stability. Modification of system characteristics using feedback control and compensation. Introduction to optimal control using Euler-Lagrange and Pontryagin's formulations. Emphasis on application of techniques to physical systems. (Also listed as Electrical Engineering 242.) 3 units. *Garg or Wright*

**231. Systems Response and Control.** Methods, applicable to design, of obtaining parameters for strength, response, and stability studies to mechanical systems. Analysis of closed loop control systems with linear transfer functions; electrical and mechanical analogs; introduction to determination of transfer function from input-output characteristics. 3 units. *Macduff or Wright*

**232. Nonlinear Analysis.** Fall semesters. Prerequisite: consent of instructor. (Also listed as Electrical Engineering 222.) 3 units. *T. Wilson*

**233. Fluid Control Systems.** A design oriented course concerned with hydraulic and pneumatic feedback control systems. Basic control system characteristics; linearized transfer functions; determination of transfer function from computation and experiment; position, velocity, and acceleration feedback devices; transducers; d.c. and a.c. hydraulic and pneumatic amplifiers. 3 units. *Macduff*

**235. Advanced Mechanical Vibrations.** Analytical and experimental procedures applied to design of machines and systems for adequate vibration control. Determination of eigenvalues and eigenvectors by iteration and computer techniques; transfer matrices applied to lumped and distributed systems; analytical and numerical methods of obtaining the pulse response of plane and three dimensional multi-mass systems; convolution and data processing; introduction to random vibration. 3 units. *Macduff*

**236. Engineering Acoustics and Noise Control.** Specification of the physical properties of noise, noise measurement, and absorption, transmission, and propagation of sound. Effects of noise on man, noise exposure, and damage risk criteria. Legal aspects of noise control, source modification, enclosures, barriers, and personnel protectors. Prerequisites: Mechanical Engineering 123 and Mathematics 111. 3 units. *Macduff*

**251. Refrigeration and Cryogenics.** Theory and experiment in the evaluation of the thermodynamic properties of refrigerants and cryogenic fluids. Thermodynamics of vapor compression, air cycle, absorption, and thermoelectric refrigeration. Production of low and very low temperatures, helium liquefiers. Two-phase flow processes. Heat exchange for refrigeration and cryogenic transfer. 3 units. *Chaddock*

**265. Advanced Topics in Mechanical Engineering.** Opportunity for study of advanced subjects related to programs within mechanical engineering tailored to fit the requirements of a small group. Prerequisites: approval of the Director of Un-



dergraduate or Graduate Studies and the instructor under whom work will be done. 1 to 3 units. *Staff*

**273. Ocean (Mechanical) Engineering.** Application of classical engineering disciplines to components and systems operating in the marine environment. Topics include marine corrosion, hydrodynamics and stability of vessels, marine power systems, man-rated pressure vessel and submersible design, Engineering concepts applied to the physiology and mechanics of diving and marine related energy resources. Prerequisite: Mechanical Engineering 101 or equivalent. 3 units. *Johnson*

**280. Nuclear Reactor Power Cycles.** Basic reactor principles and types. Examination of most feasible thermodynamic cycles for use with both stationary and mobile power plants. Consideration of safety shielding, heat transfer, fluid flow, and materials problems unique to reactor design. 3 units.

**300. Advanced Projects in Mechanical Engineering.** This course may be elected by students enrolled in a non-thesis program leading to the Master of Science degree. 3 units. *Graduate Staff*

**302. Advanced Thermodynamics.** Classical thermodynamics of inherently irreversible processes. Quantum and statistical thermodynamic analysis of properties of real substances and processes. Principles of general thermodynamics. 3 units. *Harman*

**311. Behavior of Crystalline Solids.** An advanced treatment of the dependence of structure on atomic bonding, and of properties on structure in crystalline solids. Crystal structures; phase diagrams and solid-state thermodynamics; physical properties; mechanical properties; kinetics of thermal treatments. 3 units. *Cocks, Pearsall, or Shepard*

**322. Mechanics of Viscous Fluids.** Equations of motion for a viscous fluid; general properties and selected solutions of the Navier-Stokes equations; laminar boundary layer equations with selected solutions and approximate techniques; origin of turbulence. 3 units. *Buzzard or Shaughnessy*

**323. Convective Heat Transfer.** Models and equations for fluid motion, the general energy equation, and transport properties. Exact, approximate, and boundary layer solutions for laminar flow heat transfer problems. Use of the principle of similarity and analogy in the solution of turbulent flow heat transfer. Two-phase flow, nucleation, boiling, and condensation heat and mass transfer. Prerequisite: Mathematics 285. 3 units. *Chaddock*

**324. Conduction and Radiation Heat Transfer.** Conduction heat transfer in steady and transient state. Radiation exchange involving absorbing and emitting media including gases and flames, combined conduction and radiation and combined convection and radiation. Exact and approximate methods of solution including separation of variables, transform calculus, numerical procedures, and integral and variational methods. Prerequisites: Mathematics 285 and Mechanical Engineering 222 or equivalent. 3 units. *Buzzard or Chaddock*

**327. Homogeneous Turbulence.** Stochastic methods in turbulence theory. The kinematics of homogeneous turbulence. The dynamics of decay, universal equilibrium theory, and the probability distribution of velocity. 3 units. *Shaughnessy*

**328. Turbulent Shear Flow.** The Reynolds equation and the energy balance. Turbulent transport processes. Flow in channels and pipes. The turbulent boundary layer. Free turbulence: jets, wakes, and mixing layers. Recent theoretical and experimental work. 3 units. *Shaughnessy*

**331. Nonlinear Control Systems.** Analytical, computational, and graphical techniques for solution of nonlinear systems; Krylov and Bogoliubov asymptotic method; describing function techniques for analysis and design; Liapounov functions and Lure's methods for stability analysis; Aizerman and Kalman conjectures; Popov, circle, and other frequency-domain stability criteria for analysis and synthesis. Prerequisite: Mechanical Engineering 230 or consent of instructor. 3 units. *Garg or Wright*

**333. Seminar in Control Systems.** Modern developments from the areas of system dynamics, linear, nonlinear, and optimal control; computational techniques for system analysis and synthesis; emphasis on recently published writing in the controls field; topics to be selected to match the interests of the student group; term paper required. Prerequisite: knowledge of basic linear control theory or computer programming, or consent of instructor. 3 units. *Garg*

**335. Analytical Methods in Vibrations.** Time and frequency domain analysis, generalized coordinates and Lagrange's equations, natural modes of continuous systems, approximate methods, damped systems, introduction to random vibrations. Prerequisite: Mechanical Engineering 235 or consent of instructor. 3 units. *Wright*

**372. Finite Element Techniques in Design.** Finite element methods applied to design problems in stress analysis; temperature distribution; and flow problems. Derivation of state vectors and transfer matrices for rectangular and triangular elements; accuracy and computation methods; comparison with difference equation methods and available analytical results. 3 units. *Macduff*

**399. Special Readings in Mechanical Engineering.** Individual readings in advanced study and research areas of mechanical engineering. Prerequisite: approval of the Director of Graduate Studies. 1 to 3 units. *Graduate Faculty*

## English

Professor Budd, *Chairman* (323 Allen); Professor Nygard, *Director of Graduate Studies* (315 Allen); Professors Anderson, Cady, Duffey, Ferguson, Randall, Reiss, Ryals, Smith, Turner, and Williams; Associate Professors Butters, DeNeef, Gerber, Jackson, Jones, Mellow, Monsman, and Strandberg

The department offers graduate work leading to the A.M., M.A.T., and Ph.D. degrees. A statement of the requirements for the A.M. and Ph.D. degrees may be obtained from the Director of Graduate Studies. The department requires a reading knowledge of one foreign language for the A.M. degree; for the Ph.D. degree, two languages determined by the student's committee.

### For Seniors and Graduates

**207. Old English Grammar and Readings.** 3 units. *Nygard or Reiss*

**208. History of the English Language.** Introductory survey of the changes in sounds, forms, and vocabulary of the English language from its beginning to the present, with emphasis on the evolution of the language as a medium of literary expression. 3 units. *Nygard or Reiss*

**209. Present-Day English.** A description of present-day American English from the point of view of modern linguistic theory; comparison of traditional and structural grammars; semantic change; the relation of the written to the spoken language; usage. 3 units. *Butters, Nygard, or Reiss*

**210. Old English Literary Tradition.** Prerequisite: English 207. 3 units. *Nygard or Reiss*

**212. Middle English Literary Tradition.** From 1100 to 1500 (excluding Chaucer); medieval genres; reading of selected texts. A reading knowledge of Middle English is recommended. 3 units. *Nygard or Reiss*

**215. Chaucer.** *The Canterbury Tales*. 3 units. *Nygard or Reiss*

**216. Chaucer.** *Troilus and Criseyde* and the minor poems. 3 units. *Nygard or Reiss*

**221. English Prose and Poetry of the Sixteenth Century.** Readings in the major non-dramatic forms and authors; from Sir Thomas More to John Donne. 3 units. *DeNeef*

**223. Spenser.** 3 units. *DeNeef*

**224. Shakespeare.** The plays. 3 units. *Williams*

**225, 226. Tudor and Stuart Drama, 1500-1642.** First semester: Peele, Lyly, Greene, Kyd, Dekker, Heywood, Chapman, and Marston, with emphasis on Marlowe. Second semester: Jonson, Webster, Beaumont, Fletcher, Massinger, Middleton, Ford, and Shirley. 6 units. *Randall*

**229, 230. English Literature of the Seventeenth Century.** The first semester includes works in prose and poetry from 1600 to about 1660, and the second semester includes prose, poetry, and some drama from 1660 to 1700. 3 units each semester. *DeNeef (229), Jackson (230), Randall (229,230), or Williams (229)*

**232. Milton.** Milton's poetry and prose, with emphasis on the major poems. 3 units.

**234. English Drama, 1642-1800.** The heroic play and comedy of manners of the Restoration; the important plays, serious and comic, of the eighteenth century. 3 units. *Jackson*

**235, 236. The Eighteenth Century.** First semester: Swift, Pope, Defoe, Addison, Steele, and others. Second semester: Gray, Johnson, Boswell, Collins, Goldsmith, the novelists, and other writers. 6 units. *Ferguson or Jackson*

**241, 242. English Literature of the Early Nineteenth Century.** First semester: poets and prose writers, 1790-1810, with emphasis on Wordsworth and Coleridge. Second semester: 1810-1830, with emphasis on Byron, Shelley, and Keats. 6 units. *Monsman*

**245, 246. English Literature of the Later Nineteenth Century.** First semester: Carlyle, Dickens, Thackeray, Tennyson, and Browning. Second semester: Arnold, Ruskin, Pater, George Eliot, Meredith, the Pre-Raphaelites, and Swinburne. 6 units. *Monsman or Ryals*

**251, 252. English Literature of the Twentieth Century.** Representative work of leading writers from 1900 to 1950, in fiction, drama, and poetry. First semester: Shaw, Conrad, Yeats, Wells, Bennett, Galsworthy, Ford, Synge, Forster, and Lawrence. Second semester: Joyce, Woolf, Edith Sitwell, Eliot, Huxley, Graves, Bowen, Auden, and Dylan Thomas. Critical analysis of selected texts, with discussion of techniques and ideas. 6 units. *Mellown or Smith*

**263, 264. American Literature, 1800-1865.** Emphasized in the first semester are Emerson, Thoreau, and Hawthorne; in the second semester, Poe and Melville. 6 units. *Anderson, Jones, or Turner*

**267, 268. American Literature, 1865-1915.** Selected works of representative authors. First semester: Whitman, Mark Twain, James, Howells, Dickinson, and the Local Colorists. Second semester: Crane, Norris, Dreiser, Cather or Wharton, O'Neill, Robinson, and Frost. 6 units. *Budd or Cady*

**270, 271. Southern Literature.** Emphasis in the first semester is on Byrd, Kennedy, Simms, Poe, Timrod, and the humorists; in the second, on Lanier, Harris, Cable, Twain, Glasgow, and Faulkner. 6 units. *Turner*

**275, 276. American Literature since 1915.** First semester: selected fiction from Gertrude Stein to the present. Second semester: poetry from the Imagist movement to the present. 6 units. *Duffey or Strandberg*

**280. Introduction to Folklore.** A survey of the materials of popular tradition, the folksong, the folktale, the proverb, the riddle, and other forms; the methods of folklore investigation; and the relation of these popular genres to literary tradition. 3 units. *Nygard*

**285. Literary Criticism.** Readings from the major critics, Plato to the eighteenth century, with emphasis on formative ideas and historical continuity. 3 units. *Jackson*

**287. Theory of Literature from Kant to the Present.** A survey of the literary theory; intellectual currents of Romanticism, the classic revival, the realistic schools, symbolism, and the recent analytic school. 3 units. *Duffey*

#### For Graduates

**310. Beowulf.** Reading and interpretation of the text. 3 units. *Nygard*

**312. Studies in Middle English Literature.** English literature from 1100 to 1500 (excluding Chaucer); a study of medieval genres with a close reading of selected major works. 3 units. *Nygard or Reiss*

**315. Studies in Chaucer.** 3 units. *Nygard or Reiss*

**318. Medieval Romances.** Origins, types, forms, themes; special attention to Arthurian materials. 3 units. *Reiss*

**320. Studies in Renaissance English Prose.** Close readings in various forms and authors as they reflect the culture and thought of the Renaissance. 3 units.

**324. Studies in Shakespeare.** Intensive study of carefully limited topics, together with critical analysis and interpretation of selected texts. 3 units. *Williams*

**325. Studies in the English Drama of the Sixteenth and Seventeenth Centuries.** 3 units. *Randall*

**329. Studies in the Metaphysical Poets.** A careful study of Donne, Herbert, and Vaughan against the seventeenth-century background, with some attention to their influence on other writers in the period and their impact on twentieth-century poetry. 3 units. *Williams*

**330. Studies in Dryden and His Age.** The early poems, the important odes, the religious and political poems, selected critical and controversial prose, and the heroic play and tragedy. 3 units. *Jackson*

**337. Studies in Swift.** Intensive study of the major prose; selected readings in the verse, political writings, and miscellaneous prose. 3 units. *Ferguson*

**338. Samuel Johnson's Literary Criticism and Related Topics.** 3 units. *Ferguson*



**339. The Eighteenth-Century Novel.** Richardson, Fielding, Smollett, and Sterne are emphasized. Attention is given to earlier prose fiction and to other contributing literary patterns. 3 units. *Ferguson or Jackson*

**341. Studies in English Romanticism.** 3 units.

**343. Studies in Coleridge and Carlyle.** 3 units.

**347. Studies in Victorian Poetry.** 3 units. *Monsman or Ryals*

**348. Studies in Victorian Fiction.** 3 units. *Ryals*

**349. Studies in Nineteenth-Century Nonfictional Prose.** 3 units.

**353. Studies in British Poetry of the Twentieth Century.** Detailed examination of major poetic texts with background readings in prose. 3 units. *Smith*

**354. Studies in British Prose of the Twentieth Century.** Intensive study of the writings, both fiction and non-fiction of one major British author. *Mellown or Smith*

**361. Studies in a Major American Author of the Early Nineteenth Century.** 3 units. *Anderson, Jones, or Turner*

**362. Studies in a Major American Author of the Later Nineteenth Century.** 3 units. *Budd or Cady*

**364. Hawthorne and Melville.** Extensive reading in the works of Hawthorne and Melville, and close study of selected writings. 3 units. *Jones or Turner*

**368. Studies in American Realistic Fiction.** Intensive study of a post-Civil War novelist such as Howells, with lesser attention to a representative precursor such as De Forest, and a twentieth-century writer such as Dreiser. 3 units. *Budd or Cady*

**369. Studies in American Humor.** The native tradition in the Down-East humorists and the humorists of the Old Southwest, in Mark Twain and his contemporaries, and afterward. 3 units. *Turner*

**376. Studies in Twentieth-Century American Literature.** Selected problems posed by the poetry, prose, fiction, or drama of this century. 3 units. *Duffey*

**380. The Traditional Ballad and Folksong.** Studies in English, Scottish, and American popular poetry, with attention to the textual and musical traditions. No technical knowledge of music is required. 3 units. *Nygard*

**383. Textual Criticism.** The principles of analytical bibliography and their application to problems and procedures in the study of Elizabethan printed books. 3 units. *Williams*

**387. Special Topics Seminar.** 3 units. *Staff*

## TUTORIALS

Specialized subjects of study will be offered, numbered in the 390's, to accommodate the interests of advanced graduate students. Tutorials will be offered to single students or to small groups. Instruction will be conducted in weekly sessions, or in more frequently scheduled sessions, if the instructor wishes. Emphasis will be on independent reading and investigation, and oral and written reports. A substantial amount of writing will be required.

Students are advised to consult the Director of Graduate Studies for a list of tutorials currently scheduled to be offered. 3 units. *Staff*

## For Foreign Students

**100. English for Foreign Students.** For students to whom English is a second language. Designed to perfect their speaking and understanding of the language. Drills in writing, speaking, listening, and the American idiom. Open to all students and their spouses, and to any persons and their spouses with an official connection with the University. Those who do not pay full-time student fees may register for a fee of \$5. No credit. *Staff*

## Forestry and Environmental Studies

Professor Ralston, *Dean* (213 Biological Sciences); Professor Anderson, *Director of Graduate Studies* (04 Biological Sciences); Professors Barnes, Hellmers, Jayne, Knoerr, Philpott, and Stambaugh; Associate Professors Convery, Vesilind, and Yandle; Adjunct Associate Professors Clark, Hodges, Metz, and Vukovich; Assistant Professors Rajagopal and Wuenschel

Major and minor work is offered in the natural and social aspects of forestry and related areas of natural resources leading to the Master of Arts, Master of Science, and Doctor of Philosophy degrees. Work for these degrees may be pursued in the biological science areas of tree anatomy, forest ecology, tree physiology, biochemistry, forest entomology, and forest pathology; in the environmental science areas of forest soils, meteorology, and hydrology; in resource economics; and in forest mensuration, biometry, and operations research. College graduates who have had specialized training in professional forestry or the related basic areas of the natural or social sciences will be considered for admission. Students will be restricted to the particular fields of specialization for which their academic background qualifies them. For information on professional training in forestry, the *Bulletin of the School of Forestry and Environmental Studies* should be consulted.

The specific degrees available in forestry and related natural resources through the Graduate School are: the A.M. (with or without a thesis), M.S. (with a thesis), and the Ph.D. Students majoring in forestry may be required to demonstrate satisfactory knowledge of one or two foreign languages for the Ph.D. degree. More information on degree and language requirements can be found in the program information section of the *Bulletin*.

## BIOLOGICAL SCIENCE

### Dendrology and Wood Anatomy

**206 F. Anatomy of Woody Plants.** (Also listed as Botany 206.) 4 units. *Philpott*

**241 F. Dendrology.** Nomenclature, classification, and identification of woody plants, with special reference to the tree species indigenous to southeastern United States and other important forest regions of temperate North America. Prerequisite: Biology 11-12 or equivalent. 3 units. *White*

**292 F. Microtechnique of Woody Tissue.** Preparation of wood for microscopic study including sectioning, staining, and mounting techniques; elementary photomicrography. Prerequisites: Forestry 241 and 206, or equivalents. 3 units. *Philpott*

### Ecology

**243 E.S. Natural Resource Ecology.** An introduction to modern ecology as applied to natural resource management and environmental protection. Emphasis put on the ecosystem as the basic unit of management. Prerequisite: consent of instructor. 3 units. *Wuenschel*

**277 F. Seminar in Natural Resource Allocation and Efficiency.** Evaluation of economic principles concerned with problems of natural resource allocation, with special attention to the alternatives for governmental policies in private property economics. Prerequisite: an advanced course in non-market decision-making, or Forestry 378 or equivalent. 1 unit. *Convery*

**337 E.S. Ecological Analysis for Environmental Management.** Methods of analyzing ecosystems for environmental impact assessment, land use planning, and other environmental management applications. Lectures, laboratory, and field work in use of maps, aerial photographs, and field surveys for interpretation of physiographic and biological characteristics of terrestrial ecosystems. Prerequisites: Environmental Studies 243 and 341, and consent of instructor. 3 units. *Wuenschel*

**340 E.S. Ecology and Land Use Planning.** Consideration of the properties and processes of the natural environment as they relate to land use. Exploration of the biological, economic, legal, and social aspects of the application of ecological principles to the land use planning process. Prerequisites: Environmental Studies 341 and consent of instructor. 3 units. *Wuenschel*

**341 E.S. Ecological Principles in Environmental Management.** Discussion of the application of ecological principles to environmental manipulation. Methods of planning and managing human use of ecosystems while avoiding environmental deterioration. Stress put on the biological viewpoint. Prerequisites: general ecology and Environmental Studies 243 or other substantive course work in ecology. 3 units. *Wuenschel*

**346 E.S. Seminar in Environmental Policy.** Political, legal, and socioeconomic aspects of public and private action in environmental quality control and management. Prerequisites: Forestry 269 and Environmental Studies 341, or equivalents, and consent of instructor. 1 unit. *Convery and Wuenschel*

**347, 348 E.S. Natural Resource Ecology—Environmental Management Seminar.** Discussion of current ecological and environmental problems and research topics related to the management of natural resources. Credit to be arranged. *Knoerr and Wuenschel*

**349 E.S. Wildland and Wildlife Management.** The paradox of managed natural systems is considered in the context of plant, animal, and human population dynamics. Topics include vegetation management, wildlife management, and wilderness recreation management, including camping, backpacking, hunting, and fishing. Special attention is paid to wildland preserve and open space planning. 3 units. *Staff*

**354 E.S. Biological and Resource System Simulation.** Introduction to systems terminology. Differential and difference equations. Probabilistic concepts. Time and event simulations using problem oriented languages such as CSMP, SYMAMO, and GPSS. Applications in biological and resource sciences. Prerequisites: Forestry 250 F and 253 F, or consent of instructor. 3 units. *Rajagopal*

## Entomology

**222 F. Biology of Forest Insects and Diseases.** Fundamentals of entomology and plant pathology as applied to forest protection; coordinated laboratory work with emphasis on identification and interpretation of forest and wood degradation. 4 units. *Anderson and Stambaugh*

**225 F. Chemical Aspects of Forest Protection.** Chemical aspects of organisms attacking trees and of materials used in their control. Emphasis on structures and

properties in relation to functions and uses. Prerequisite: Forestry 222 F. 3 units. *Barnes*

**230 F. Forest Entomology.** Identification, biology, and control of insects that cause damage to trees and wood products. Emphasis of diagnosis is on the characteristics of the damage and the stages of the insects responsible. Prerequisite: Forestry 222, or equivalent, or consent of instructor. 4 units. *Anderson*

**233 F. General Entomology.** Principles of morphology, physiology, metamorphosis, and taxonomy of insects. Prerequisite: one course in entomology or zoology, or consent of instructor. 4 units. *Anderson*

**331 F. Toxicology of Insecticides.** Study of the physical, chemical, and biological properties of materials used to destroy insects. Formulation, toxicology, and insect physiology as related to insecticide action are emphasized. Prerequisite: one course in entomology; organic chemistry is recommended. 3 units. *Anderson*

**332 F. Ecology of Forest Insects.** The influence of environmental factors on the vital processes of insects with emphasis on how both the abiotic and biotic elements influence the fluctuation of forest insect populations. Prerequisite: one course in entomology or zoology, or consent of instructor. 3 units, or 4 units with laboratory. *Anderson*

**335 F. Entomological Research Techniques.** Problem analyses, scientific writing, and laboratory and field research methods which are especially applicable to entomological problems. 2 units. *Anderson*

**385 F. Seminar in Forest Protection.** Discussion of current problems in entomology and pathology and evaluation of topical research for protection and control application in forest resource management. Prerequisites: Forestry 223 and 230. 1 unit. *Anderson and Stambaugh*

## Pathology

**222 F. Biology of Forest Insects and Diseases.** (See description under Entomology.)

**223 F. Forest Pathology.** Survey of major diseases of North American forests and their timbers, with emphasis on current literature. Field and laboratory study in diagnosis and infection biology. Prerequisite: Forestry 222 or equivalent, or consent of instructor. 4 units. *Stambaugh*

**225 F. Chemical Aspects of Forest Protection.** (See description under Entomology.) 3 units. *Barnes*

**321 F. Phytopathological Technique in Forestry.** Fundamentals of phytopathology and their application to field and laboratory investigations of tree diseases and wood degradation; biological interpretation of host-pathogen-environment interaction is stressed in literature review, experimentation, and scientific writing. Prerequisite: Forestry 223 or equivalent. 4 units. *Stambaugh*

**322 F. Microbiology of Forest Soils.** Qualitative and quantitative characterization of the microbial populations of forest soils with emphasis on rhizosphere interactions in root pathogenesis and mycorrhizal development; epidemiology of root diseases of trees; principles of control. Prerequisite: consent of instructor; mycology or bacteriology is recommended. 4 units. *Stambaugh*

**385 F. Seminar in Forest Protection.** (See description under Entomology.)

## Physiology and Biochemistry

**205 F. Tree Growth and Development.** Life processes, growth, and develop-



ment of trees, with emphasis on physiological processes and environmental influences on structure, composition, and function. 3 units. *Barnes*

**207 F. Chemistry of Woody Tissues.** Composition of wood at the elemental, molecular, and macromolecular levels; both in woody plants and in processed woods. Distribution and properties of main components, and methods of analysis. Prerequisite: organic chemistry or consent of instructor. 3 units. *Barnes*

**208 F. Physiology of Wood Formation.** Processes involved in the growth and development of woody tissues, including internal control mechanisms and effects of environmental stresses on structure and composition. Prerequisites: Forestry 201 and 241, or equivalents. 3 units. *Barnes*

**225 F. Chemical Aspects of Forest Protection.** (See description under Entomology.) 3 units. *Barnes*

**305 F. Forest Biochemistry.** Biochemistry applied to structure and function of woody plants and associated fungi and insects. Prerequisites: courses in plant physiology and chemistry. 3 units. *Barnes*

## ENVIRONMENTAL SCIENCE

### Soils

**261 F. Forest Soils.** Origin, development, and classification of soils with special emphasis on those developed in humid climates; morphological, physical, and chemical properties of soils in relation to growth of trees; effect of forests on soils. Prerequisites: one year of introductory chemistry and one semester of introductory physics; physical geology, mineralogy, petrology, and analytical chemistry are recommended. 3 units. *Ralston*

**362 F. Forest Soil Physics.** Analysis of the physical properties of soil related to the growth and development of forest trees. Consideration is given to the significance of soil moisture, temperature, aeration, and structural characteristics in the analysis of forest growth relationships. Prerequisite: Forestry 261. 3 units. *Ralston*

**364 F. Soil Classification and Mapping.** Classification of soils as natural bodies. Mapping of soils, land use classes, and forest site classes; field study will be made of soils in either the coastal plain or mountains. Prerequisite: Forestry 261. 3 units. *Ralston*

**366 F. Forest Soil Fertility.** The relationships of soil fertility factors in the growth of forest trees. Emphasis is placed on the analysis of soil factors related to the mineral nutrition of trees. Prerequisite: Forestry 262; analytical chemistry is recommended. 3 units. *Ralston*

### Meteorology

**203 F. General Meteorology.** A general introduction to the science of meteorology, particularly for students concerned with problems in biology and hydrology. Emphasis is placed on the fundamentals and role of atmospheric thermodynamics and energy and mass transfer processes in determining both local and regional aspects of weather and climate. 3 units. *Vukovich*

**204 F. Microclimatology.** Introduction to the micrometeorological processes. Discussion of the integration of these processes and the resulting microclimates in the rural (forest, field, and water surface) and urban environments. Methods for modification of the microclimate. 3 units. *Knoerr*

**215 F. Air Pollution Meteorology.** The theory of transport and diffusion of air

pollutants and its application to practical problems and computations involving both single sources and multiple sources, including urban communities; modeling of transport and diffusion, both in wind tunnels and computers; stack design from the meteorological point of view; the organization of meteorological networks and field studies; the measurement, monitoring, and equipment requirements of pertinent meteorological parameters; air pollution climatology; meteorological management of air pollution. Prerequisite: an introductory course in general meteorology or Forestry 203 or equivalent. Course sponsored by Triangle Universities Consortium on Air Pollution and taught by faculty from North Carolina State University. 3 units. *Staff*

**217 F. Environmental Instrumentation.** Theory and application of the physical basis for measuring parameters of natural and controlled environments. Properties and effective utilization of contemporary electronic measurement and data acquisition systems. Methods for obtaining and processing computer compatible experimental records. Three lectures and three laboratory hours per week. Prerequisite: consent of instructor. Students should have a basic knowledge of the properties of environmental parameters and be able to write computer programs. 4 units. *Knoerr*

**304 F. Atmospheric Turbulence and Diffusion.\*** Bulk and molecular aspects of atmospheric turbulence. Navier-Stokes equations and the Reynold's stresses. Mixing-length and statistical turbulence theories. Similarity hypotheses. Turbulent transfer and diffusion in adiabatic and diabatic atmospheres. Characteristics of turbulence in various scales of motion from the planetary to subinertial range. Prerequisites: Forestry 203 and differential equations, or consent of instructor. 3 units. *Vukovich*

**306 F. Dynamics of Local Atmospheric Motion.\*** Characteristics of atmospheric motion in the 100 m to 100 km scale. Analytic development from hydrodynamic and thermodynamic equations, incorporating appropriate scale forcing functions of heating and terrain roughness. Theory and characteristics of land and sea breezes, mountain and valley breezes, mountain waves and local modification of large scale atmospheric motion. Prerequisites: Forestry 203 and differential equations, or consent of instructor. 3 units. *Vukovich*

**344 F. Micrometeorology and Biometeorology Seminar.\*** Advanced topics in the physics of the surface environment of the earth, with emphasis on plant and animal microclimates; budgets of mass, momentum, and energy; vertical structure of wind, temperature, water vapor, and carbon-dioxide in relation to exchange processes within the biosphere. Prerequisites: Forestry 204, or equivalent, and consent of instructor. 2 units. *Knoerr*

## Hydrology

**216 F. Watershed Hydrology.** Influence of vegetation, soil types, and land forms on water yield, water quality, and flood potential. Analysis of precipitation patterns, infiltration rates, erosion forces, and sediment carrying capacities of streams. Techniques and research methods used to control the hydrologic cycle, water quality and water yield on wild lands. 3 units. *Hellmers*

**342 F. Hydrologic Processes.\*** Physical processes of the hydrologic cycle with emphasis on those processes which can be modified or controlled by watershed management. 3 units. *Knoerr*

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\*Offered on demand.

## RESOURCE ECONOMICS AND POLICY

**269 F. Resource Economics and Policy.** Development and critical review of concepts useful in understanding and evaluating the distribution of natural resource use over time in terms of the relations between technological knowledge, group and individual behavior, and social institutions. 3 units. *Convery*

**270 F. Economics of Forestry.** Development of the principles of economics useful in the analysis of the past, present, and prospective supply and demand situations for forestry goods and services: problems of the economics of the firm and industry, basic and peculiar to forestry, with special attention to the time dimensions of value; the role of forestry in the general economy including attention to relevant institutional factors. Prerequisite: Forestry 269 or one course in the principles of economics. 3 units. *Convery*

**273 E.S. Economics and Environmental Quality.** Consideration of the economic dimensions of the environmental problem. Exploration of the reasons for market failure; investigation of possible remedies, including a tax on residuals and direct control. Examination of the modifications required in cost-benefit and input-output analysis to incorporate environmental values. Discussion of economic growth, natural resource scarcity, and environmental quality. Prerequisite: consent of instructor. 3 units. *Convery*

**277 F. Seminar in Natural Resource Allocation and Efficiency.** Evaluation of economic principles concerned with problems of natural resource allocation, with special attention to the alternatives for government policies in private property economics. Prerequisite: an advanced course in non-market decision-making, or Forestry 378 or equivalent. 1 unit. *Convery*

**378 F. Seminar in Forest Economics.** Examination and discussion of the application of economic concepts in forestry, the potential contribution of economic analysis to private and public forest management; current research in forest economics. Prerequisite: Forestry 270 or consent of instructor; advanced courses in economics and economic theory are recommended. 2 units. *Convery*

## STATISTICS AND OPERATIONS RESEARCH

**250 F. Biometry.** Concepts and methods of statistics essential to the collection, analysis, and interpretation of resource and biological data. Emphasis is placed on problems of estimation, inference, and decision-making with experimental data. 3 units. *Yandle*

**251 F. Theory and Methods for Sampling Biological Populations.** Introductions to statistical methods for sampling natural resources and biological populations. Simultaneous consideration is given to theoretical and experimental problems in the design and applications of sampling methods and in the interpretation of sample data. Prerequisite: Forestry 250 or consent of instructor. 3 units. *Yandle*

**253 F. Computer Science in Natural Resources.** Organization of information storage and retrieval systems. Extensive use of Fortran (WATFIV) programming and statistical packages (SAS, TSAR) in resource and environmental decision-making. 3 units. *Rajagopal*

**258 F. Quantitative Analysis in Resource Management.** Mathematical model formulation and analysis in resource and environmental decision-making. Includes a survey of applications of linear programming, dynamic programming, CPM-

PERT, inventory and statistical quality control in the resource sciences. Use of APL and MPS programming systems. 4 units. *Rajagopal*

**352 F. Theory and Applications of Linear Statistical Models.** Theoretical development of the general linear statistical model, together with extensions to accommodate linear approximation of nonlinear cases. Curve-fitting techniques are developed, with emphasis on applications to natural phenomena. Prerequisite: consent of instructor. 3 units. *Yandle*

**353 F. Design and Analysis of Experiments.** Extension of the theory of estimation and testing for general linear models to include the less than full rank case. Experimental design models such as factorial and incomplete block models are developed as special cases of the general theory. Emphasis is placed on field and laboratory designs, together with appropriate computerized analysis techniques. Prerequisite: Forestry 352. 3 units. *Rajagopal*

**354 E.S. Biological and Resource System Simulation.** Introduction to system terminology. Differential and difference equations. Probabilistic concepts. Time and event simulations using problem oriented languages such as CMSP, DYNAMO, and GPSS. Applications in biological and resource sciences. Prerequisites: Forestry 250 and 253, or consent of instructor. 3 units. *Rajagopal*

## SPECIAL STUDIES AND RESEARCH

**299 F. Special Studies in Forestry.** Work on the senior-graduate level to meet the needs of individual students offered in the areas of forestry and related natural resources designated under Forestry 357, 358. Hours and credit to be arranged. *Staff*

**299 E.S. Independent Projects in Environmental Studies.** Work at the senior-graduate level to meet the needs of individual students in several areas of environmental studies. Hours and credit to be arranged. *Staff*

1. Environmental Planning. *Staff*
2. Environmental Economics. *Convery*
3. Applied Ecology. *Wuenschel*
4. Environmental Education. *Wuenschel*
5. Environmental Communication and Media. *Wuenschel*
6. Environmental Ethics and Values. *Wuenschel*
7. Environmental Design. *Staff*
8. Environmental Policy. *Convery*
9. Environmental Systems Analysis. *Rajagopal*

**301, 302 F. Advanced Studies in Forestry.** Work on the advanced graduate level to meet the needs of individual students offered in the areas of forestry and related natural resources designated under Forestry 357, 358. Hours and credit to be arranged. *Staff*

**301, 302 E.S. Advanced Projects in Environmental Studies.** Independent work at the advanced graduate level in areas designated under Environmental Studies 299. *Staff*

**357, 358 F. Research in Forestry.** Students with adequate training may undertake special research problems under direction of members of the faculty in the following branches of forestry and related natural resources. Credit to be arranged.

1. *Forest Ecology.* Prerequisite: Environmental Studies 243 or equivalent. *Wuenschel*
2. *Forest Soils.* Prerequisite: Forestry 261 or equivalent. *Ralston*
3. *Silviculture.* Prerequisites: Environmental Studies 243 and Forestry 244, or equivalents. *White*
4. *Forest Management.* Prerequisite: Forestry 281 or equivalent. *Chaiken*
5. *Forest Economics.* Prerequisite: Forestry 270 or equivalent. *Convery*



6. *Wood Anatomy and Properties*. Prerequisites: Forestry 241 and 206, or equivalents. *Philpott*
7. *Forest Mensuration and Biometry*. Prerequisites: Forestry 250 and 352, or equivalents. *Yandle*
8. *Forest Entomology*. Prerequisite: Forestry 230 or equivalent. *Anderson*
9. *Forest Operations Research*. Prerequisite: consent of instructor. *Rajagopal*
10. *Dendrology*. Prerequisite: Forestry 241 or equivalent. *White*
11. *Forest-Tree Physiology*. Prerequisites: plant physiology and plant or forest ecology. *Barnes or Hellmers*
12. *Forest Pathology*. Prerequisites: plant physiology and Forestry 223, or equivalents. *Stambaugh*
13. *Forest Meteorology and Hydrology*. Prerequisites: Forestry 203 or 342, or equivalents. *Knoerr*
14. *Forest Biochemistry*. Prerequisites: plant physiology and organic chemistry. *Barnes*
15. *Regional Land Use Planning*. Prerequisites: Environmental Studies 337 and 340. *Staff*
16. *Environmental Studies*. Prerequisite: consent of instructor. *Staff*

**368 F. Field Seminars.** Field studies, consultations, and visits to areas of interest during spring vacation period or at other times, in the several branches of forestry and related natural resources listed under Forestry 357, 358. Credit to be arranged. *Staff*

## RELATED COURSES IN OTHER DEPARTMENTS

Many courses available in other departments of the University are related to the biological, environmental, economics and policy, and biometrics and operations research areas of forestry and other natural resources. These courses offered in botany, zoology, biochemistry, chemistry, physics, engineering, mathematics, economics, business administration, sociology, and political science may be utilized by graduate students in the School of Forestry. For a specific listing of pertinent courses available in other departments see the *Bulletin of the School of Forestry and Environmental Studies*.

## The University Program in Genetics

Professor Gross, *Director* (Biochemistry); Professors Amos (Microbiology and Immunology), Gillham (Zoology), and Guild (Biochemistry); Associate Professors Antonovics (Botany), Boynton (Botany), Counce (Anatomy), C. Ward (Zoology), F. Ward (Microbiology and Immunology), and Webster (Biochemistry); Assistant Professors Hall (Biochemistry), and Kredich (Biochemistry)

The University Program in Genetics provides a coherent course of study in all facets of biology related to genetics. Graduate students registered in any of the biological sciences departments may apply to the faculty of the genetics program to pursue study and research leading to an advanced degree. It would be helpful if applicants for admission to the Graduate School indicated their interest in the genetics program at the time of application. Requests for information describing more completely the research interests of the staff, facilities, and special stipends and fellowships should be addressed to the Director, Genetics Program (151 Nanaline H. Duke).

### For Seniors and Graduates

**204. Introductory Genetics.** An introduction to genetic analysis with emphasis on the molecular basis of mutation, segregation, function, and organization of the genetic material. Primarily for medical students but graduate students may be admitted with the instructor's consent. (Also listed as Biochemistry 204.) 2 units. *Gross or Staff*

**216. Molecular Genetics.** An advanced course on genetic mechanisms and their relationship to nucleic acids and their synthesis. Prerequisites: introductory courses in biochemistry and genetics, or consent of instructor. (Also listed as Biochemistry 216.) 4 units. *Guild or Staff*

**280. Principles of Genetics.** An introduction to the structure and properties of genes and chromosomes and to the evolution of genetic systems. Prerequisites: introductory courses in biology, chemistry, and mathematics. (Also listed as Botany 280 and Zoology 280.) 3 units. *Antonovics, Boynton, or Gillham*

**282. Experimental Genetics.** A series of laboratory exercises and discussions on the molecular mechanisms of mutation, recombination, replication, transcription, and translation of the genetic material. May be taken concurrently with Genetics 280. Prerequisite: consent of instructor. (Also listed as Biochemistry 282.) 2 units. *Modrich or Staff*

**284. Current Topics in Genetic Mechanisms.** A seminar and lecture course devoted to the analysis of the current literature in molecular genetics. Given in response to adequate demand. Prerequisites: Genetics 280 or equivalent, and consent of instructor. (Also listed as Biochemistry 284.) 1 unit. *Hall or Staff*

**285. Population Genetics.** A seminar and lecture course devoted to the analysis of the current literature in population genetics. Prerequisites: Genetics 280, or equivalent, and consent of instructor. (Also listed as Botany 285.) 3 units. *Antonovics or Staff*

**286. Evolutionary Mechanisms.** Evolutionary mechanisms in population ecology and population genetics of plants and animals: natural selection, adaptations, species interactions, mating systems, fitness concepts, and genetic divergence. Prerequisites: college biology and Genetics 280 or equivalent. (Also listed as Botany 286 and Zoology 286.) 3 units. *Antonovics and H. Wilbur*

**287. Quantitative Genetics.** Methods of analyzing genetic variation in continuous traits. Models of continuous variation, genetic, environmental and interaction components; genetic correlation; heritability estimation; selection response. Prerequisites: a course in genetics, Botany 280, or equivalent; consent of instructor. (Also listed as Botany 287.) 3 units. *Antonovics*

**288. Seminar on the Role of the Cell in Development and Heredity.** Topics of current interest and controversy. Prerequisites: a course in genetics and consent of instructor. (Also listed as Anatomy 288 and Zoology 288.) 2 units. *Counce*

## For Graduates

**336. Immunogenetics.** Antigens of tissues and organs, distribution, extraction, and chemistry. Phylogeny of iso-antigenic systems of man and animals. Test for histocompatibility including lymphocyte interaction and reactivity. Change in antigenicity and immune responsiveness in carcinogenesis. Immunologic factors in pregnancy and in homotransplantation of organs. (Also listed as Microbiology and Immunology 336.) 2 units. *Amos or Ward*

**351-352. Genetics Seminar.** Required of all students specializing in genetics. (Also listed as Biochemistry 351-352.) 1 unit each semester. *Gross or Staff*

## Geology

Professor Heron, *Chairman* (119 Science); Professor Perkins, *Director of Graduate Studies* (111 Science); Professor Pilkey; Associate Professors Furbish and Lynts; Assistant Professor Rosendahl

The Department of Geology offers graduate work leading to the M.S. and Ph.D. degrees. An undergraduate degree in geology is not a prerequisite for graduate studies, but a student must have had or must take a summer field geology

course (or equivalent experience), mineralogy, sedimentary rocks, stratigraphy, paleontology, and structural geology. In addition, the student must have had one year of college chemistry, one year of college physics, and mathematics through calculus.

Graduate courses in the Department of Geology are designed to provide specialized training in the fields of geological oceanography, sedimentology, stratigraphy, paleontology, geophysics, and low-temperature mineralogy.

An acceptable thesis is required. There is no language requirement for the M.S. degree.

The Ph.D. degree is available through the Earth Science Consortium, a new inter-university doctoral program combining the faculties and research facilities of Duke, Emory, and Tulane Universities. The Earth Science Consortium offers specialization in the areas of paleontology, sedimentology, stratigraphy, marine geology, geophysics, environmental geology, and regional geology. Under this program, a student admitted to Duke University would be expected to spend one year of study at another of the participating universities. Such a program offers the student a broadly-based faculty with diverse research interests and the opportunity to pursue graduate education in a variety of geologic settings. Normally, a candidate would hold the master's degree at the time of admission to the program. Additional information concerning the details of the doctoral program is available on request.

### For Seniors and Graduates

**205. Geological Oceanography.** Broad geologic aspects of the ocean basins, including origin, bottom physiology, sediment distribution, and sedimentary processes. Field observations; sampling procedures. Not open to students who have completed Geology 206. Given at Beaufort. 6 units. *Glaser and Pilkey*

**206S. Principles of Geological Oceanography.** A survey of geological aspects of the oceans including sediment types, processes of sedimentation, geologic structures of the ocean basins, and bottom physiography. Prerequisite: Geology 108 or consent of instructor. 3 units. *Pilkey*

**208. Shallow-Marine Geology.** Physical and biological processes responsible for sediment production, accumulation, and alteration in the shallow-marine environment. Prerequisite: Geology 108 or consent of instructor. Given biennially. 3 units. *Perkins*

**211S. Stratigraphic Principles and Application.** Prerequisite: Geology 108. 3 units. *Perkins*

**212. Facies Analysis.** Sedimentological models for the environmental interpretation of sedimentary sequences. Prerequisite: Geology 211. 3 units. *Perkins*

**214S. Sediments in Thin Section.** Study of sediments and sedimentary rocks using the petrographic microscope and related techniques. Prerequisite: consent of instructor. 3 units. *Perkins*

**222. Sedimentary Minerals.** Structure and geologic occurrences of selective detrital and authigenic minerals including the clay minerals. Theory and use of X-ray diffraction, differential thermal analysis, and thermal gravimetric analysis. Prerequisite: Geology 102 or consent of instructor. 3 units. *Heron*

**229. Economic Geology.\*** Principles and processes involved when elements are

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\*Offered on demand.

concentrated to economic proportions in magmatic, metamorphic, hydrothermal, sedimentary, or surface environments. Prerequisite: Geology 102. 3 units. *Furbish*

**230. Principles of Structural Geology.** Description, origin, and interpretation of primary and secondary geologic rock structures. Prerequisites: Geology 106 and 108. 3 units. *Rosendahl*

**241-242. Invertebrate Paleontology.** Biologic and stratigraphic relationships of fossil invertebrates, with special emphasis on evolutionary trends of invertebrates as interpreted from fossil evidence. Lectures and laboratory. Prerequisites: Geology 1 and 72, or consent of instructor. Given biennially. 6 units. *Lynts*

**243-244. Micropaleontology.** Microscopic animal and plant fossils, exclusive of spores and pollen, with special emphasis on their biology, taxonomy, evolution, and stratigraphic distribution. Lectures and laboratory. Prerequisites: Geology 241 and 242, or consent of instructor. Given biennially. 6 units. *Lynts*

**247. Paleocology.** Application of ecologic and geologic principles to the reconstruction of the interrelationship between organisms and their environment in geologic time. Prerequisites: Geology 213 and 242, or consent of instructor. Given biennially. 3 units. *Lynts*

**250. Introduction to Marine Geophysics.** Topics include seismic reflection and refraction, magnetics, gravity, and seismology. Prerequisite: introductory physics or consent of instructor. Given at Beaufort. 6 units. *Rosendahl*

**251. Principles of Geophysics.** Theory, techniques, and interpretation. Aspects of seismology, geomagnetism, gravity, and heat flow. Prerequisites: Physics 52, Mathematics 32, Geology 1, or consent of instructor. 3 units. *Rosendahl*

**252. Marine Geophysics.** Survey of methods in the study of the oceanic crust and mantle. Prerequisite: Geology 251 or consent of instructor. Given biennially. 3 units. *Rosendahl*





## For Graduates

**300. Seminar in Oceanography.\*** 1 to 3 units. *Staff*

**305. Seminar in Continental Drift and Global Tectonics.** Given biennially. 3 units. *Lynts*

**310. Seminar in Stratigraphy.\*** 1 to 3 units. *Staff*

**312. Seminar in Sedimentology.\*** 1 to 3 units. *Staff*

**320. Seminar in Mineralogy.\*** 1 to 3 units. *Staff*

**330. Seminar in Geochemistry.\*** 1 to 3 units. *Staff*

**340. Seminar in Paleontology.\*** 1 to 3 units. *Staff*

**350. Seminar in Geomathematics.\*** 1 to 3 units. *Staff*

**360. Seminar in Geophysics.\*** 1 to 3 units. *Staff*

**371, 372. Advanced Topics in Geology.\*** To meet the individual needs of graduate students for independent study in various environmental sedimentary fields. 1 to 3 units. *Staff*

## Germanic Languages and Literature

Professor Phelps, *Chairman and Director of Graduate Studies* (106 Languages); Professor Jantz; Associate Professors Borchardt and Rolleston; Assistant Professors Alt and Rosenberg

The Department of Germanic Languages and Literature offers graduate work leading to the A.M. degree. Students who expect to major in German should have had sufficient undergraduate courses in Germanic languages to enable them to proceed to more advanced work.

Students who wish to take courses in German as a related field should normally have completed a third-year course (in exceptional cases, a second year) of college German with acceptable grades.

## For Seniors and Graduates

**201S, 202S. Goethe.** His life and works, in the light of his lasting significance to Germany and world literature. First semester: lyrics, prose, fiction, and selected dramas; second semester: *Faust I & II*. 6 units. *Jantz or Phelps*

**203S. Eighteenth Century.** Eighteenth-century German literature in its relation to European intellectual currents of that time. 3 units. *Phelps*

**205, 206. Middle High German.** The language and literature of Germany's first classical period. 6 units. *Rosenberg*

**207S. German Romanticism.** The principal writers of the period from 1795 to 1830. 3 units.

**209S. Drama.** Studies in the German-speaking theater with emphasis on the nineteenth century. 3 units. *Alt*

**211S. Nineteenth-Century Literature.** From the end of Romanticism through Realism. 3 units. *Alt*

**214S. The Twentieth Century.** Literature of the twentieth century presented through representative authors. 3 units. *Rolleston*

**215S. Seventeenth-Century Literature.** Leading writers of the Baroque, viewed against the background of their time. 3 units. *Borchardt*

**216. History of the German Language.** Development of the phonology, morphology, and syntax of German from the beginnings to the present. 3 units. *Rosenberg*

**217S. Renaissance and Reformation Literature.** The period from 1400 to about 1600. 3 units. *Borchardt*

**218S. The Teaching of German.** A survey of modern teaching techniques: problems in the teaching of German on the secondary and college levels. Analysis and evaluation of textbooks and related audiovisual materials. 3 units. *Phelps*

**219. Applied Linguistics.** The application of modern linguistic principles to a systematic study of the phonetics, morphology, and syntax of modern German. Prerequisite: consent of instructor. 3 units. *Rosenberg*

**230. Lyric Poetry.** Studies in poetry and poetic theory. From Goethe and the Romantics to Rilke, Benn, and contemporary authors. 3 units. *Rolleston*

**232. Criticism.** Critical concepts, craft of interpretation, and readings from the great critics. 3 units. *Alt* or *Borchardt*

#### For Graduates

**301. Gothic.\*** 3 units. *Rosenberg*

**321, 322. Germanic Seminar.** 3 units each semester. *Alt, Borchardt, Phelps, or Rolleston*

## Health Administration

Associate Professor Jaeger, *Chairman* (263 Baker House); Assistant Professor Smith, *Director of Graduate Studies* (237 Baker House); Professors Brown and Warren; Adjunct Professor Kaluzny; Associate Professors McCool, Minniear, and Swanson; Visiting Associate Professor Cummins; Adjunct Associate Professors Coulter and Peck; Assistant Professors Blanks, Delaney, Falcone, and Warner; Lecturer Winfree; Research Associate Cusic; Associate Hunter

Graduate study leading toward preparation for a career in the administration of all types of health organizations and programs is offered through a twenty-month academic program that leads to the M.H.A. degree. Students without previous administrative experience in the health field are urged to undertake a twelve-month administrative residency following graduation. This residency is a period of varied administrative experience that is conducted under faculty supervision and is individually designed around each student's interests. For students without previous administrative experience, the residency should be considered an integral part of the M.H.A. program. Admission to this program is based upon suitability of the candidate to assume leadership roles in the organization and management of the delivery of health services, as well as on capability for graduate study.

**301. The Health System and Its Environment.** An introduction to the organization and management of health services from a systems perspective. Emphasis is on the evolution of the present system and on the interplay of forces within the system and between the system and its environment. 4 units. *Jaeger*

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\*Offered on demand.

**312. Comparative Health Systems.** A comparative examination of the structure and performance of the health systems of the United States and other countries, particularly Canada and Great Britain. Topics include current financing, capitalization, utilization, control, and the relative roles of the governmental and private sectors. 2 units. *Falcone*

**314. Social Dimensions of Health Services.** An epidemiological examination of health and disease in different population groups and their implications with regard to the structure and operation of health care delivery systems. 2 units. *Smith*

**321. Operations Research for Health Administration.** Development of a quantitative modeling framework derived from the concepts of the systems approach to analyze management decisions in health administration. The focus of the course is on the knowledge and skills needed to manage the analysis (i.e., formulation, assumptions, interpretation, cost of analysis) rather than on performing the analysis, emphasizing the process of analysis over detail of techniques. Decisions are treated deterministically and stochastically, and on a scale from simple to complex. Techniques that serve the framework include calculus, inventory theory, PERT, decision analysis, fixed vs. variable cost analysis, queuing, simulation, and mathematical programming. The latter part of the course presents the concepts of quantitative control. 4 units. *Warner*

**322. Public Policy and Health Care.** A study of the development and present status of selected public policy issues within their social, economic, and political contexts. Alternative courses of possible public action are reviewed and their probable outcomes are assessed. 2 units. *Falcone*

**324. Institutional Health Services.** A broad examination of the provision of health services in institutional settings. The principal focus is on the general hospital, but attention is also given to the mental hospital and other long-term care institutions. Specific study, utilizing lectures and cases, is made of the administrative and informational organization; the structure and function of each department; relationships between administration and the governing board, the medical staff, and the community; operational and capital financing; the planning function; and the evaluation of performance. 4 units. *Blanks*

**326. Health Economics.** The current state of knowledge with regard to the economics of health and medical care. Attention is given to the unique problems of demand and supply in the health services sector, as well as the implications of private and public financing alternatives; restrictions on manpower entry; incentive mobility; and problems of productivity measurement and change. 2 units. *Cummins*

**331, 332. Planning Health Services.** This course sequence addresses the planning for the delivery of health services, both at the systems level (area; community) and at the organizational level (institutions; program). Emphasis is on analytic techniques, measurement and evaluation, and the dynamics of the planning process. The courses include use of case studies and simulations. 4 units each semester. *Smith and Swanson*

**335. Ambulatory Health Services.** This course covers the noninstitutional components of the organization and provision of personal health services. The principal emphasis is on medical group management, including forms of organization, financing of services, physician-patient relationships, medical records, and peer review. Other topics include dental care, home care, halfway houses, multiphasic screening, and community health and mental health centers. 3 units. *Hunter*

**341, 342. Case Studies in Health Administration.** An integrating course sequence consisting of analysis of cases taken from institutional and programmatic health services settings. 3 units each semester. *Staff*

**344. Health Manpower.** An analysis of the human resources component of the health services system, including professional and non-professional elements; resource development and distribution; occupational structure; assignment policies and staffing patterns; performance evaluation; and collective bargaining. 4 units. *McCool*

**346. Community Health Services.** The focus of this course is the organization and management of health services directed toward general populations rather than individuals. Coverage includes aspects of environmental and occupational hygiene, nutrition and housing, planning community health services, preventive health education and programs, and other public health activities. Included are the problems associated with health status measurements and assessment. 3 units. *Cusic*

**348. Legal and Regulatory Constraints on Health Services.** This course treats the legal relationships between elements of the health system and the larger society of which it is a part. Attention is devoted to the certification, operation, and performance of health manpower, organizations, and services, and the difficulties in establishing effective restraints to minimize undesired results. The approach to the course includes the study of selected legislation, court cases, and research findings that assist in understanding formal constraints that affect the operation of the health systems. 2 units. *Warren*

**360. Seminar in Health Administration.** This seminar examines current issues confronting the delivery of health services. The focus is on managerial responses to these issues and the effect that these responses are likely to produce on the organization. 3 units. *Brown*

**371, 372. Directed Research.** Credit to be arranged. *Staff*

### **Management Sciences Courses for Students in Health Administration**

**MS 300. Managerial Economics.** The fundamental theory of the firm on which analysis and planning of economic activity is based. Topics include: consumer demand, perfect competition, imperfect competition, capital theory, and welfare economics. Emphasis will be placed on the application of these theories to existing corporate resource allocation problems. 4 units.

**MS 310. Quantitative Methods.** Mathematics for optimization with and without constraints in linear and nonlinear systems. Topics include partial derivatives, LaGrange multipliers, Kuhn-Tucker conditions, matrix algebra, and linear programming. A linear programming lab develops an understanding of problem translation into standard formats. 4 units.

**MS 311. Statistical Analysis for Management Decisions.** Builds upon Management Sciences 310 and extends to an examination of classical and Bayesian statistics as a framework and methodology for decision-making. Included are topics such as sampling theory, estimation, hypothesis testing, regression and correlation analysis, utility theory, and statistical decision theory. 4 units.

**MS 320. Organization Analysis and Design.** A macroscopic study of organizations as socioeconomic-political systems for collective action embedded in an uncontrollable environment. Specific topics include: (1) alternative theories of organization, with particular emphasis on modern systems and cybernetic ap-



proaches, and (2) introduction to organization design with particular emphasis on goal formation, performance measurement, decomposition, administrative mechanisms for coordination and control, and organization change and adaptation. 4 units.

**MS 330. Accounting Systems I.** Introduces the student to the types of information requirements imposed on the firm by agencies in its environment and develops an understanding of the activities of the firm within the framework of a financial accounting system designed to satisfy these information requirements. The financial accounting system is treated as an input-output information gathering and reporting system which provides a conceptual model of the firm and reflects the impact of exchange transactions between the firm and its environment. Emphasis is given to the study of financial accounting, reporting, and measurement problems from a theoretical and an applied basis, using cases and topical problems in financial accounting as a foundation for the learning experience. 3 units.

**MS 331. Accounting Systems II.** Establishes the relationships between the strategies of the firm as reflected in its planning activities and the impact of those plans on the data gathering, reporting activities, and operations inside the firm. The concept of the master budget is used to establish a basis for quantifying the planning activities of the firm and for developing a financial feedback and control system to serve as a mechanism for internal management and control. Specific topics include flexible budgeting, standard costing, control in a programmed environment, capital budgeting and analysis of variance. Cases, together with a variety of brief problem exercises, are utilized as a basis for material in this course. 3 units.

**MS 384. Market Structures.** A simultaneous treatment of the organization's decisions on its cooperative and competitive behavior, and on the design of its internal structure and its operations. The subject of the course is the organization's coordinated treatment of the decision variables which reflect its direct relations to the economic units with which it cooperates and competes to effect exchange transactions, and those which relate to the form of its internal operations and organizational structures. 2 units.

**MS 385. Short- and Long-Run Planning.** An integrated treatment of the functional areas of the firm in the context of short-run and long-run decision problems. Topics include: forecasting, cash management, program budgeting, fund accounting, investment decisions in plant, equipment and product, choice of technology, cost of capital and taxes. 3 units.

## History

Professor Durden, *Chairman* (235 Allen); Professor Young, *Director of Graduate Studies* (237 Allen); Professors Colton, Davis, Ferguson, Holley, Hollyday, Lerner, Oates, Preston, Ropp, A. Scott, W. Scott, TePaske and Watson; Associate Professors Cell, Chafe, Gavins, Goodwyn, Hartwig, Maier, Mauskopf, Miller, Nathans, Witt, and Wood; Assistant Professors Bergquist, Dirlik, and Stone; Visiting Professors Addington and Higginbotham

The Department of History offers graduate work leading to the A.M. and Ph.D. degrees. Candidates for the A.M. degree must have a reading knowledge of at least one ancient or modern foreign language related to their programs of study and have completed successfully a substantial research paper, normally the product of a year's seminar or two semester-courses. The paper must be approved by two readers—the supervising professor and a second professor from the graduate staff. Students anticipating a May degree must have their papers read and ap-

proved by April 15; those anticipating a September degree must have their papers read and approved by August 15.

Candidates for the degree of Doctor of Philosophy are required to prepare themselves for examinations in four fields. Three usually shall be history. The choice of fields is determined in consultation with the student's supervisor and the Director of Graduate Studies. The department offers graduate instruction in the fields of Africa, Afro-American history, ancient history, medieval and early modern Europe, modern Europe, American history, Britain and the Commonwealth, Imperial Russia, modern Russia, Latin America, South Asia, modern China, modern Japan, military history, history of science, and history of medicine. The candidate for the Ph.D. degree usually must have a reading knowledge of two foreign languages, but in certain cases where the candidate's supervisor and the Director of Graduate Studies approve, and where the candidate's research for the dissertation would appreciably benefit, an alternative to the second language may be accepted. This alternative usually would take the form of successfully completed formal training in an auxiliary discipline (such as statistics or a course in one of the other social sciences with an emphasis upon methodology) of 3 to 6 units, or the equivalent, depending on the student's program. It also must be in addition to any previous undergraduate work in the discipline. The requirement, whether satisfied by two languages or by one language and an alternative, must be met prior to the preliminary examination.

**Ancient History.** For courses in ancient history which may be taken for credit in either history or classical studies, see Classical Studies.

### For Seniors and Graduates

Students may receive credit for either semester of a hyphenated course at the 200-level without taking the other semester if they obtain written consent from the instructor.

**201S, 202S. Aspects of Change in Prerevolutionary Russia.** Origin and dynamics of the Russian revolutionary movement, the intelligentsia, and the emergence of the labor movement. 6 units. *Miller*

**203. The Uses of History in Public Policy: I.** (Also listed as Public Policy Sciences 271.) 3 units. *Goodwyn*

**204. The Uses of History in Public Policy: II.** (Also listed as Public Policy Sciences 273.) 3 units. *Kuniholm*

**205S. Progressive Era in the United States and World War I.** 3 units. *Watson*

**206S. The Nineteen Twenties and the New Deal in the United States.** 3 units. *Watson*

**207S, 208S. The Development of Urban America.** The process of urbanization from rural society to the modern city. 3 units each semester. *Decker or A. Scott*

**209, 210. Selected Topics in Afro-American History, 1619-Present.** Critical issues of the collective experience of Afro-Americans with special attention to Black institutional development. 6 units. *Gavins*

**212. Recent Interpretations of United States History.** A course designed to encourage a critical evaluation of major issues in United States history through examination of recent interpretations of key problems. (Open only to history graduate students and seniors doing practice teaching in one of their final two semesters.) 3 units. *Watson and Staff*

**215-216. The Diplomatic History of the United States.** (Not open to undergraduates who have had History 121-122.) 6 units. *Davis*

**217. Fascism and Its Background.** Emphasis on Italy and Germany, with attention also to France and Eastern Europe. 3 units. *Maier*

**218. Twentieth Century Europe.** Social and economic issues: inflation, mass unemployment, and international economy. 3 units. *Maier*

**221. Problems in the Economic and Social History of Europe, 1200-1700.** 3 units. *Witt*

**222. Problems in European Intellectual History, 1250-1550.** 3 units. *Witt*

**223S, 224S. The Old Regime, the Enlightenment, and the French Revolution.** Political, social, and intellectual trends in seventeenth- and eighteenth-century Europe, with emphasis on France and the French Revolution. 6 units.

**227-228. Recent United States History: Major Political and Social Movements.** 6 units. *Chafe*

**229. Recent Interpretations of Modern European History.** A course designed to develop the ability to appraise critical historical issues through the study and discussion of recent interpretations of key historical problems in modern European history. (Open only to history graduate students and seniors doing practice teaching in one of their final two semesters.) 3 units.

**231S, 232S. Problems in the History of Spain and the Spanish Empire.** 6 units. *TePaske*

**234. Political Economy of Development: Theories of Change in the Third World.** (Also listed as Political Science 234.) 3 units. *Bergquist and Valenzuela*

**237S. Europe in the Early Middle Ages.** 3 units. *Young*

**238S. Europe in the High Middle Ages.** 3 units. *Young*

**240. Aspects of Traditional and Modern African Culture.** Introduction to the oral and written literatures and musical and artistic traditions. 3 units. *Hartwig*

**241-242. Modernization and Revolution in China.** 6 units. *Dirlik*

**247. History of Modern India and Pakistan, 1707-1857.** Analysis and interpretation, with special emphasis on social and economic change. 3 units.

**248. History of Modern India and Pakistan, 1857 to the Present.** 3 units.

**249-250. Social and Intellectual History of the United States.** The interplay of ideas and social practice through the examination of attitudes and institutions in such fields as science and technology, law, learning, and religion. 6 units. *Holley*

**255S-256S. Problems in African History.** 6 units. *Hartwig*

**260. Economic History of Japan.** (Also listed as Economics 232.) 3 units. *Bronfenbrenner*

**261-262. Problems in Soviet History.** Studies in the background of the Revolution of 1917 and the history and politics of the Soviet state. 6 units. *Lerner*

**263-264. American Colonial History and the Revolution, 1607-1789.** The founding and institutional development of the English colonies; the background, progress, and results of the Revolution. 6 units. *Wood*

**265S, 266S. Problems in Modern Latin American History.** 6 units. *Bergquist*

**267S-268S. From Medieval to Early Modern England.** The intellectual, social, and political problems of transition to modern England, with special emphasis on the English Renaissance. 6 units. *Ferguson*

**269-270. British History, Seventeenth Century to the Present.** Historiography of social structure and social change: English Revolution, party, the Industrial Revolution, class and class consciousness, Victorianism, and the impact of war in the twentieth century. 6 units. *Cell*

**272. Poverty in the United States: An Historical Perspective.** (Also listed as Public Policy Sciences 272.) 3 units. *Decker*

**273, 274. Topics in the History of Science.** Critical stages in the evolution of scientific thought. 6 units. *Mauskopf*

**275S, 276S. Central Europe, 1848-1918.** Conflict between liberalism and authoritarianism, clash of nationalities, diplomatic interaction, emphasizing domestic changes in Germany and Austria-Hungary. 6 units. *Hollyday*

**277S. The Coming of the Civil War in the United States, 1820-1861.** 3 units. *Durden*

**278S. The Civil War in the United States and its Aftermath, 1861-1900.** 3 units. *Durden*

**280. Historiography.** Great historians since Herodotus and an examination of recent twentieth-century trends. 3 units.

**283. Political and Social Change in the United States, 1789-1860.** 3 units. *Nathans*

**285S, 286S. Oral History.** Research on race relations and civil rights in the United States in the twentieth century using techniques of oral history. 3 units each semester. *Chafe and Goodwyn*

**287-288. History of Modern Japan.** The political, economic, and social development of Japan since 1750; factors contributing to Japan's emergence as a modern state. 6 units. *Stone*

**297S. The British Empire of the Nineteenth Century.** The development of the Empire from the American Revolution to the imperialism that culminated in the South African War. 3 units. *Preston*

**298S. The Commonwealth in the Twentieth Century.** The origins and evolution of the Commonwealth of Nations and its adjustment in the age of anticolonialism. 3 units. *Preston*

### Seminars for Graduates

**307-308. Seminar in United States History.** 3 units each semester. *American History Staff*

**317-318. Seminar in the History of Western Europe.** 3 units each semester. *Hollyday and Scott*

**371-372. Research Seminars.** To be taken either in conjunction with colloquia listed below or by special arrangement with graduate instructors. When research seminars are not offered, independent research in a desired area may be worked out with the Director of Graduate Studies and the appropriate graduate instructor. These seminars do not appear on the official schedule of courses.



**401. Seminar on the British Commonwealth.** 3 units. *Preston or Others of the Committee on Commonwealth Studies*

### Colloquia for Graduates

Each colloquium deals with an aspect of history by means of readings, oral and written reports, and discussion, with attention to bibliography. Ad hoc colloquia may be worked out during registration in the various fields represented by members of the graduate faculty; these colloquia do not appear on the official schedule of courses. In some instances, students may take the equivalent of a research seminar in conjunction with the colloquium and will be credited with an additional 6 units by registering for 371.1-372.1, etc.

### Historiography and the Teaching of History—For Graduates

**312. Seminar in the Teaching of History in College.** The work in this course is intended to acquaint students with the problems involved in teaching history in college. Required of all candidates for the degree of Doctor of Philosophy who are in residence for two years at Duke. As an alternate method of meeting this requirement, a graduate student may, in cooperation with a member of the faculty, serve a one-semester teaching apprenticeship. Year course. No credit. Supervised by Director of Graduate Studies.

**314. Historical and Social Science Methodology.** Methods used in historical research with emphasis upon the various social science approaches. 3 units. *Chafe*  
History 314 or History 280 is required of all candidates for the Ph.D. degree who are in residence for two years at Duke University.

### Independent Study

**399.** Supervised independent study and reading, with consent of professor. 3 units.

## Marine Sciences—The University Program

Professor Costlow, *Director*; Professors Bookhout (Zoology), Johnson\* (Botany), and Pilkey\* (Geology); Associate Professors Barber (Zoology and Botany) and Searles\* (Botany); Assistant Professors Baier (Chemistry), Forward (Zoology), Gutknecht (Physiology), Sullivan (Biochemistry), and Sutherland (Zoology)

Training in the marine sciences at Duke University includes marine biology, marine geology, and oceanography. The departments which are chiefly concerned are botany, chemistry, geology, and zoology.

Graduate students working in the marine sciences will take their degrees under the auspices of one of the above departments and must, therefore, meet the requirements of that department. During the first part of the training the student will usually take courses on the Durham campus during the academic year and enroll in more specialized courses in the marine sciences at the Duke University Marine Laboratory during the summer. After the completion of the course work and preliminary examination (for doctoral candidates) the candidate may, with approval of the major professor, request space for thesis research at the Marine Laboratory.

Persons interested in graduate work in marine sciences should apply through

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\*In residence at the Marine Laboratory during the summer only.

one of the appropriate departments. Forms may be obtained from the Graduate School.

Applications for summer courses at the Laboratory should be addressed to the Director, Duke University Marine Laboratory, Beaufort, North Carolina 28516. The form may be obtained from the Duke University *Marine Laboratory Bulletin*. The application for enrollment in the Duke University summer session should be accompanied by transcripts of undergraduate and graduate work. Applications should be received before March 10.

Students registering for research should do so under the appropriate departmental numbers.

The following courses are offered during the summer at Beaufort. See the Duke University *Marine Laboratory Bulletin* for the current schedule of courses.

### For Seniors and Graduates

**202. Phytoplankton Systematics.** Taxonomy and classification of marine phytoplankton: their general characteristics, phytogeography, life histories, and techniques for preservation, preparation, and enumeration of phytoplankton samples. Individual projects. Given at Beaufort. (Listed as Botany 202.) 6 units. *Staff*

**203. Marine Ecology.** The application of ecological theory to marine systems. Mathematical properties of population growth and species interactions; field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current literature. Prerequisites: a course in general zoology or invertebrate zoology, and calculus; knowledge of statistics is recommended. (Also listed as Zoology 203L.) 6 units. *Staff*

**204. Marine Microbiology.** The major groups of marine microorganisms: bacteria, fungi, protozoa, and phytoplankton—their taxonomy, culture, physiology, and ecology. Field and laboratory work with observational and experimental methods on the dynamics of marine microorganisms. Prerequisite: a course in general biological science or botany. Given at Beaufort. (Listed as Botany 204.) 6 units. *Johnson*

**205. Geological Oceanography.** The study of the broad geologic aspects of the ocean basins, including origin, bottom physiography, sediment distribution, and sedimentary processes. Observations in the field will be emphasized and will include training in sampling procedures for both shallow and deep water. This course is not open to students who have completed Geology 206. Given at Beaufort. (Also listed as Geology 205.) 6 units. *Pilkey*

**211. Marine Phycology.** An introduction to marine algae: their identification, taxonomy, morphology, physiology, and ecology. Field trips are complemented by laboratory study, culturing, and preparation of herbarium material. (Listed as Botany 211.) 6 units. *Searles*

**212. Membrane Physiology and Osmoregulations.** Physiology of marine and estuarine organisms, with emphasis on cellular transport processes and electrophysiology. Includes the functions, mechanisms, and comparative aspects of ionic and osmotic regulation in plants and animals. Laboratory work deals with membrane transport in single cells and epithelia, electrophysiology and synaptic transmission in mollusks, renal and gill transport processes in fish, amino acid transport and metabolism in crustaceans, and the application of radiotracer and other physical and chemical techniques to the study of membrane function. Prerequisite: consent of instructor. (Listed as Physiology 212.) 6 units. *Gutknecht*

**214. Biological Oceanography.** Adaptations of organisms for life in the sea,

the impact of biological processes on the nonliving components of the marine environment provide the core of the biological oceanography course. Ideas emphasized are: cycling of energy and matter through marine ecosystems; role of physical and chemical processes in regulating the abundance; distribution; community organization of marine organisms. A cruise on the R/V *Eastward* will investigate the physical and chemical processes which support the biological productivity of the continental shelf ecosystem. Prerequisite: consent of instructor. (Listed as Zoology 214.) 6 units. *Barber*

**230. Environmental Oceanography.** Chemical, biological, and geological aspects of pollution in the marine environment. Anthropogenic effects upon natural marine processes on shore lines and shelves. Application of marine science to utilization of marine resources. Prerequisite: consent of instructor; physical chemistry is recommended. Given at Beaufort. (Also listed as Chemistry 230.) 6 units. *Baier and Staff*

**240. Chemical Oceanography.** Distribution, alternation, and transport of chemical species in the marine environment. Field cruises to gather samples for evaluating chemical processes in the ocean. Lectures, laboratory work, and field trips. Prerequisite: consent of instructor. Physical chemistry is recommended. (Also listed as Chemistry 240.) 6 units. *Baier*

**250. Physiological Ecology of Marine Animals.** The physiology of marine and estuarine animals in relation to certain environmental factors (temperature, salinity, oxygen, and light). Prerequisites: courses in physiology and general zoology. (Listed as Zoology 250.) 6 units. *Forward*

**252. Marine Electrobiology.** The physiology and behavioral consequences of bioelectric activity ranging from the cell membrane to the interanimal communication level. Laboratory work deals with bioelectric recording and stimulation techniques with particular emphasis placed on electrophysiological studies of marine organisms wherein cellular correlates of animal behavior are clearly seen. Ionic basis of bioelectric signals, transmission of signals within and between cells, relation of bioelectric signals to particular behavioral patterns, effects of externally applied electric fields, bioelectric communication and navigation systems. Prerequisite: consent of instructor. Summer. Given at Beaufort. (Also listed as Biomedical Engineering 252.) 6 units. *Wachtel and Wolbarsht*

**274. Marine Invertebrate Zoology.** Study of invertebrate animals in the Beaufort region. Field trips will be made to a variety of habitats to study and collect animals in their natural environment. The structure and habits of living invertebrates and their behavior under experimental conditions will be studied in the laboratory. (Zoology 274 is not intended for students who have had a graduate course in invertebrate zoology.) Prerequisite: a course in general zoology or general biology. (Listed as Zoology 274.) 6 units. *Barnes*

**276. Comparative and Evolutionary Biochemistry.** Lectures and discussion of the origin of life, evolution of the genetic code, mutation and protein polymorphism, natural selection and protein structure, and comparison of homologous proteins and nucleic acids. Laboratory work involves the purification and characterization of homologous proteins from fish and invertebrates. Techniques used include salt fractionation, electrophoresis, ion-exchange and molecular exclusion chromatography, fingerprinting, molecular weight determination, amino acid composition, and other related approaches. Prerequisite: consent of instructor. Given at Beaufort. (Listed as Biochemistry 276.) 6 units. *Sullivan*

**278. Invertebrate Embryology.** Lectures, readings, and laboratory work dealing

with rearing, development, and life histories of invertebrates. Prerequisite: consent of instructor. Given at Beaufort. (Also listed as Zoology 278.) 6 units. *McClay*

**353, 354. Research.** Hours to be arranged. Prior approval of instructor at the Duke University Marine Laboratory is required. (For graduate students only.) *Staff*

## Mathematics

Professor Warner, *Chairman* (135C Physics); Professor Weisfeld, *Director of Graduate Studies* (230 Physics); Professors Allard, Arthur, Carlitz, Murray, Reed, and Shoenfield; Associate Professors Burdick, Hodel, Kitchen, Kraines, Moore, Scoville, and Smith; Adjunct Associate Professor Chandra; Assistant Professors Butler, Cantor, Lees, Protter, Reznick, and Wolpert

Graduate work in the Department of Mathematics is offered leading to the M.S., A.M., and Ph.D. degrees. Students, in their undergraduate work, must have had courses in differential and integral calculus, and at least 6 semester hours of other courses in mathematics on the junior or senior level.

The department offers a program in applied statistics with a minor in computer science leading to the M.S. degree. The program consists of 24 units of graded course work plus a thesis involving the use of the computer.

All A.M. and Ph.D. degree candidates are required to pass a comprehensive examination in the areas of real and complex analysis and algebra. Students will usually take the comprehensive examination after completing their first year of graduate study and just prior to the start of their second year.

The A.M. degree with a major in mathematics is awarded primarily on the basis of scholarship. It requires 30 units of graded work in addition to the comprehensive examination. A thesis may be substituted for 6 units of course work only in unusual circumstances.

The Ph.D. degree in mathematics is awarded upon the demonstration of ability and training in research. The original dissertation, therefore, is the most important of the formal requirements for the degree.

Since a reading knowledge of French, German, and Russian is highly desirable for a student of mathematics, the Ph.D. degree candidate should satisfy the language requirement in two of these languages as early as possible. The department offers departmentally administered language examinations as an alternative to the ETS examinations.

### For Seniors and Graduates

**204. Geometry for Teachers.** Metric and synthetic approaches to plane and solid geometry; affine geometry, and an algebraic model of Euclidean geometry. 3 units. *Staff*

**206. Introduction to Stochastic Processes.** Elementary theory and application of stochastic process models; Poisson processes, counting processes, discrete parameter Markov chains. Prerequisite: Mathematics 135. 3 units. *Staff*

**207, 208. Introduction to Algebraic Structures.** Groups, rings, fields; isomorphism theorems; partial and total orderings; characterizations of basic number systems; permutation groups; finitely generated Abelian groups; polynomial rings; principal ideal domains; division and Euclidean algorithms; vector spaces; linear transformations and matrices; bilinear forms; multilinear algebra; determinants; finite dimensional inner product spaces. Prerequisites: Mathematics 103 and 104 for 207; and 207 for 208. 6 units. *Warner*

**217, 218. Intermediate Analysis.** Elementary point set topology and differen-



tial calculus in  $n$ -space; implicit and inverse function theorems; integration theory; differentiable manifolds; differential forms; generalized Stokes' theorem. Prerequisite: Mathematics 103 and 104 for 217; and 217 for 218. 6 units.

**221, 222, 223. Numerical Analysis.** For a description of these courses, see Computer Science 221, 222, 223. 3 units each semester. *Patrick*

**227, 228. Theory of Numbers.\*** Congruences, arithmetic functions, compound moduli, quadratic reciprocity, Gauss sums, quadratic forms, sums of squares. Prerequisites: Mathematics 103 and 104 for 227; and 227, or equivalent, for 228. 6 units. *Staff*

**229, 230. Algebraic Numbers.\*** Ideals, unique factorization, divisors of the discriminant, determination of the class number. Prerequisites: Mathematics 207 for 229; and 229 for 230. 6 units. *Carlitz*

**231. Applications of Graph Theory.** Linear graphs, matrix representations, cycle structure, isomorphism, connectivity, independence, planarity, coloring, directed graphs, flows in networks as applied to engineering, management, computer science, urban systems, chemistry, physics, economics, sociology, psychology. Prerequisites: Mathematics 103 and 104, or equivalents. 3 units. *Staff*

**234. Sample Designs.\*** Methods of constructing and analyzing survey designs; elements of simple random sampling, stratified sampling, multistage sampling; methods of estimation; questionnaire construction; refusal and not-at-homes. Prerequisite: Mathematics 183. 3 units. *Staff*

**235, 236. Algebra.** Elementary categorical algebra; groups with operators,  $G$ -sets structure groups; commutative algebra; principal ring modules; structure of rings and modules; field theory. Prerequisites: Mathematics 208, or equivalent, for 235; and 235 for 236. 6 units. *Staff*

**244. Analysis of Variance.** Multiple regression, univariate and multivariate ANOVA, multiple comparisons (Scheffe, Tukey, etc.), factorial designs, analysis of covariance, repeated measurement designs. Prerequisite: Mathematics 183 or equivalent. 3 units. *Staff*

**245, 246. Combinatorial Analysis.\*** Generating functions, permutations, distributions, partitions, compositions, trees, and networks. Prerequisite: calculus. 6 units. *Carlitz*

**247, 248. Arithmetic of Polynomials.\*** Field theory, detailed study of finite fields, special polynomials and functions, valuation theory, the zeta function. Prerequisites: Mathematics 207, or consent of instructor, for 247; and 247 for 248. 6 units. *Carlitz*

**256. Orientation for Applied Mathematics.** Simulation and related notions; relation of science and technology with evolution of mathematics; modern generalizations of the concepts of language, validity, empirical science, and statistical inference. Areas of application for various specific mathematical topics. Prerequisites: Mathematics 103 and 104. 3 units. *Murray*

**260. Design of Experiments.** Factorial and fractional factorial designs, confounding, balanced and partially balanced block designs, response surface methodology, method of steepest ascent, comparison of criteria for optimality of design. Prerequisite: Mathematics 136. 3 units. *Burdick*

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\*Offered on demand.

**262. Non-Parametric Statistics.\*** A study of statistical tests in which no assumption about the underlying distribution is made; single and multiple sample tests for nominal and ordinal scales; non-parametric measures of correlation, efficiency of tests. Prerequisite: Mathematics 136 or consent of instructor. 3 units. *Staff*

**265, 266. Homological Algebra and Its Applications.** Categorical algebra; derived categories and homology; sheaves and their cohomology; applications to smooth manifolds and to complex manifolds; preschemes and schemes and their local cohomology. Prerequisites: Mathematics 236 and 271, or consent of instructor. 6 units. *Weisfeld*

**268. Mathematical Foundations of General Relativity.** Review of special relativity, the structure of Lorentz manifolds, curvature tensors and geodesics, the momentum-energy tensor and the Einstein field equations, the Schwarzschild solution and gravitational collapse. Prerequisites: Mathematics 104 or 111; Physics 42 or consent of instructor. (Also listed as Physics 268.) 3 units. *Cantor*

**269, 270. Recursive Function Theory.** Basic properties, enumeration theorems, hierarchies, recursive functions of higher types, generalized recursion theory; applications. Prerequisite: Mathematics 187 or consent of instructor. 6 units. *Shoenfield*

**271. Point Set Topology.** Basic topological properties, including compactness, connectedness, separation axioms, and countability properties; metric spaces; product and function spaces. Prerequisite: Mathematics 139 or equivalent. 3 units. *Staff*

**272. Introductory Algebraic Topology.** Fundamental group and covering spaces; homology groups of cell complexes; classification of compact surfaces; the cohomology ring and Poincaré duality for manifolds. Prerequisite: Mathematics 271. 3 units. *Staff*

**273. Algebraic Topology.** Fibrations, cofibrations and Puppe sequences; homology, cohomology, and homotopy theories; Hurewicz isomorphisms theorem; Brown representation theorem; generalized cohomology theories. Prerequisite: Mathematics 272. 3 units. *Staff*

**274. Geometric Topology.** Handle decomposition of manifolds, isotopy extension theorem; geometric and algebraic intersection numbers; Whitehead torsion and the  $s$  cobordism theorem. Prerequisite: Mathematics 272. 3 units. *Staff*

**275, 276. Probability.** Foundations of probability; random variables; distributions; central limit problem; law of large numbers; limit and ergodic theorems. Prerequisite: Mathematics 291 or consent of instructor. 6 units. *Staff*

**284. Least Squares Analysis of Linear Models.** General linear models; geometrical interpretations; multiple regression; one-way and multi-way analysis of variance; fixed, random, and mixed models; experimental design models; analysis of covariance; introduction to nonlinear models. Prerequisite: Mathematics 136. 3 units. *Burdick*

**285. Applied Mathematical Methods I.** Heat equation, wave equation, separation of variables, Fourier series, introduction to Hilbert space, Fourier transform, potential theory; complex variables, residues. Prerequisites: Mathematics 103 and 104. 3 units. *Reed*

**286. Applied Mathematical Methods II.** Eigenvalue problems, integral equations, Fredholm alternative, bounded linear transformations on Hilbert space, ap-

plications to partial differential equations, techniques for approximating eigenvalues. Prerequisites: Mathematics 103 and 104. 3 units. *Reed*

**287, 288. Foundations of Mathematics.\*** Propositional calculus, predicate calculus, axiomatized number theory. Gödel completeness and incompleteness theorems. Recursive functions; hierarchies; constructive ordinals. Set theory; consistency of the axiom of choice. Prerequisite: Mathematics 208 or Philosophy 103, or consent of instructor. (Also listed as Philosophy 287, 288.) 6 units. *Shoenfield*

**289. Mathematical Methods in Quantum Mechanics.** Hilbert space, self-adjoint operators, the mathematical model of quantum mechanics, commutation relations, spectral analysis of Hamiltonians, time dependent scattering theory, theory of group representations. Prerequisites: Mathematics 285 and 286, or equivalents. *Reed*

**290. Stochastic Processes.** Foundations and probabilistic structure of stochastic processes; sample function properties, processes with finite second-order moments, stationary processes; representations. Prerequisite: Mathematics 275. 3 units. *Staff*

**291, 292. Analysis I, II.** Measure and integration theory; introduction to functional analysis; theory of analytic functions. Prerequisite: Mathematics 218 or 140, or consent of instructor. 6 units. *Staff*

**293. Multivariate Statistics.** Basic multinormal distribution theory, the multivariate general linear model including the use of Hotelling's  $T^2$  statistic and the Roy union-intersection principle, principal components, canonical analysis, and factor analysis. Prerequisite: Mathematics 284 or consent of instructor. 3 units.

**295. Mathematical Foundations of Statistical Inference.\*** Inference-theoretic approach to hypothesis testing, decision-making, and estimation; Neyman-Pearson fundamental lemma; uniformly most powerful tests; Fisher's information and sufficiency; invariance and unbiasedness. Prerequisite: Mathematics 275 or consent of instructor. 3 units. *Staff*

**297, 298. Axiomatic Set Theory.** Statement and development of Zermelo-Fraenkel axioms. Consistency and independence problems. New axioms and their consequences. Prerequisite: consent of instructor. 6 units. *Shoenfield*

## For Graduates

**303, 304. Advanced Theory of Numbers.\*** Cubic and quartic reciprocity, partitions and diophantine analysis, sums of squares. Prerequisite: Mathematics 288 or consent of instructor. 3 units each semester. *Carlitz*

**325, 326. Analysis III, IV.** Advanced topics in complex and real analysis, measure and integration theory, functional analysis. Prerequisites: Mathematics 292 for 325; and 325 for 326. 3 units each semester. *Murray*

**327, 328. Partial Differential Equations.\*** Boundary and initial value problems, regularity and existence theorems by methods of *a priori* estimates and functional analysis. Representations of solutions, spectral theory, and potential theory. Prerequisite: Mathematics 291 and 292, or consent of instructor. 3 units each semester. *Staff*

**329, 330. Theory of Distributions.\*** Test functions, distributions, topological vector spaces, applications to the operational calculus, partial differential equations, and mathematical physics. 3 units each semester. *Staff*

**331, 332. Advanced Topics in Complex Variables.\*** Entire and meromorphic

functions; harmonic functions and potential theory; Riemann surfaces; several complex variables. 3 units each semester. *Staff*

**333, 334. Analytic Theory of Numbers.\*** Distributions of primes, primes in an arithmetic progression. Waring and Goldbach problems, applications of elliptic functions. Prerequisites: Mathematics 291 and 292. 3 units each semester. *Carlitz*

**335, 336. Topics in Algebra.\*** Advanced topics in algebra to be selected from areas of current research. Prerequisite: Mathematics 236 or consent of instructor. 3 units each semester. *Staff*

**343, 344. Differential Equations.\*** Manifolds, sheaves, differential operators and their prolongations, Spencer sequences, delta-cohomology, existence theorems for analytic partial differential equations, the delta-estimate, D-Neumann problem. Prerequisites: Mathematics 236, 272, and 292, or consent of instructor. 3 units each semester. *Staff*

**353, 354. Topics in Analysis.\*** Advanced topics in real and complex analysis to be selected from areas of current research. Prerequisite: Mathematics 325 (may be taken concurrently). 3 units each semester. *Staff*

**361, 362. Hilbert Space.** Spectral theory for Hermitian and unitary transformations; maximal symmetric transformations; canonical resolution of closed transformations; singular integral equations; the Weyl circle; indices for differential operators; deficiency characteristics of closed transformations; topologies for bounded transformations; von Neumann algebras; resolution theory; Abelian and factor rings. Prerequisites: Mathematics 236 and 292, or consent of instructor. 3 units each semester. *Murray*

**371, 372. Dimension Theory.\*** Theory of covers in normal spaces; inductive and covering dimension of metric spaces and of normal spaces; dimension of Euclidean spaces, mapping in spheres and applications; metric dimension and other metric-dependent functions. Prerequisites: Mathematics 271 and 272. 3 units each semester. *Hodel*

**375. Advanced Point Set Topology.** Advanced topics in point set topology to be selected from areas of current research. 3 units each semester. *Hodel*

**377, 378. Topics in Topology.\*** Advanced topics in topology to be selected from areas of current research. 3 units each semester. *Staff*

**383, 384. Lie Groups and Algebras.\*** Differential manifolds; Lie groups; one-parameter subgroups; Lie algebras; differential forms; classification and representations of compact Lie groups and semisimple Lie algebras; solvable and nilpotent algebras; Ado's theorem. Prerequisites: Mathematics 236 and 271, and either Mathematics 218 or 291. 3 units each semester. *Shoenfield*

**392. Nuclear Spaces.\*** The theory of nuclear locally convex spaces, as developed by Grothendieck and Pietsch; applications to spaces of distributions. Prerequisite: Mathematics 292. 3 units. *Moore*

**393. Topological Groups.\*** Elementary theory; Haar measure; compact groups; locally compact Abelian groups; duality theory. Prerequisites: Mathematics 236 and 272, or consent of instructor. 3 units. *Warner*

**394. Topological Rings.\*** Compact, locally compact, and linearly compact rings. Prerequisite: Mathematics 393 or consent of instructor. 3 units. *Warner*

**395, 396. Topological Algebra.\*** Normed and locally convex spaces. Branch algebras. Prerequisites: Mathematics 236 and 292, or consent of instructor. 3 units each semester. *Moore*



397, 398. Seminar in Algebra and Number Theory.\* Prerequisite: consent of instructor. 3 units each semester. *Carlitz*

## Program in Medieval and Renaissance Studies

The graduate Program in Medieval and Renaissance Studies is administered by the Duke University Committee on Medieval and Renaissance Studies. For a description of the program see p. 46; for a description of individual courses see listings under the specified department.

### DEPARTMENT OF ART

- 233. Early Medieval Architecture. *Sunderland*
- 237. French Renaissance Art. *Jenkins*

### DEPARTMENT OF CLASSICAL STUDIES

#### Latin

- 221. Medieval Latin I. *Newton*
- 222. Medieval Latin II. *Newton*
- 225. Paleography. *Newton*
- 305. Latin Seminar V. Prerequisite: consent of instructor. *Newton*
- 306. Latin Seminar VI. Prerequisite: consent of instructor. *Newton*
- 312. Proseminar in Latin Paleography. *Newton*

#### Classical Studies

- 327. Seminar in Byzantine History. *Rigsby*

### DEPARTMENT OF ENGLISH

- 207. Old English Grammar and Readings. *Nygard or Reiss*
- 208. History of the English Language. *Nygard or Reiss*
- 210. Old English Literary Tradition. *Nygard or Reiss*
- 212. Middle English Literary Tradition. *Nygard or Reiss*
- 215, 216. Chaucer. *Nygard or Reiss*
- 221. English Prose and Poetry of the Sixteenth Century.
- 223. Spenser. *DeNeef*
- 224. Shakespeare. *Williams*
- 225, 226. Tudor and Stuart Drama, 1500-1642. *Randall*
- 229. English Literature of the Seventeenth Century. *DeNeef, Randall, or Williams*
- 232. Milton.
- 310. Beowulf. *Nygard*
- 312. Studies in Middle English Literature. *Nygard or Reiss*
- 315. Studies in Chaucer. *Nygard or Reiss*
- 318. Medieval Romances. *Reiss*
- 320. Studies in Renaissance English Prose.
- 324. Studies in Shakespeare. *Williams*
- 325. Studies in the English Drama of the Sixteenth and Seventeenth Centuries. *Randall*
- 329. Studies in the Metaphysical Poets. *Williams*
- 383. Textual Criticism. *Williams*

### DEPARTMENT OF GERMANIC LANGUAGES AND LITERATURE

- 205, 206. Middle High German. *Borchardt or Rosenberg*
- 215S. Seventeenth Century Literature. *Borchardt*
- 216. History of the German Language. *Rosenberg*
- 217S. Renaissance and Reformation Literature. *Borchardt*

### DEPARTMENT OF HISTORY

- 221. Problems in the Economic and Social History of Europe, 1200-1700. *Witt*
- 222. Problems in European Intellectual History, 1250-1550. *Witt*
- 237S. Europe in the Early Middle Ages. *Young*
- 238S. Europe in the High Middle Ages. *Young*
- 267S-268S. From Medieval to Early Modern England. *Ferguson*

## DEPARTMENT OF PHILOSOPHY

218. Medieval Philosophy. *Mahoney*

## DEPARTMENT OF RELIGION

- 219. Augustine. *Gregg*
- 236. Luther and the Reformation in Germany. *Steinmetz*
- 241. Problems in Reformation Theology. *Steinmetz*
- 251. The Counter-Reformation and the Development of Catholic Dogma. *Raitt*
- 334. Theology and Reform in the Later Middle Ages. *Steinmetz*
- 336. Christian Mysticism in the Middle Ages. *Raitt*
- 338. Calvin and the Reformed Tradition. *Steinmetz* or *Raitt*
- 339. The Radical Reformation. *Steinmetz*
- 344. Zwingli and the Origins of Reformed Theology. *Steinmetz*

## DEPARTMENT OF ROMANCE LANGUAGES

### French

- 213. French Literature of the Seventeenth Century. *Melzer*
- 214. The "Moralistes" of the Seventeenth Century. *Melzer*
- 219. Old French Literature. *Vincent*
- 224. History of the French Language. *Hull*
- 225. French Prose of the Sixteenth Century. *Tetel*
- 226. French Poetry of the Sixteenth Century. *Tetel*
- 311, 312. French Seminar (Medieval and Renaissance Topics). *Tetel* and *Vincent*

### Italian

- 284. Dante. *Fowlie*
- 285. Dante. *Caserta*
- 288. The Renaissance. *Tetel*

### Spanish

- 251. The Origins of Spanish Prose Fiction. *Wardropper*
- 252. Spanish Lyric Poetry before 1700. *Wardropper*
- 253. The Origin of the Spanish Theater. *Wardropper*
- 257. History of the Spanish Language. *Garci-Gómez*
- 258. Medieval Literature. *Garci-Gómez*
- 265. Cervantes. *Predmore* or *Wardropper*
- 266. Drama of the Golden Age. *Wardropper*
- 321, 322. Hispanic Seminar (Medieval and Renaissance Topics). *Garci-Gómez*, *Predmore*, or *Wardropper*

## Microbiology and Immunology

Professor Joklik, *Chairman* (414 Jones); Professor Willett, *Director of Graduate Studies* (420 Jones); Professors Amos, Burns, Day, Metzgar, Osterhout, and Wheat; Associate Professors Bolognesi, C. Buckley III, R. Buckley, Lang, Rosse, Scott, Seigler, Smith, Snyderman, Vanaman, Ward, and Zweerink; Assistant Professors Collins, Cresswell, Dawson, Gooding, Koren, Lauf, Leis, Levy, Miller, and Mitchell

The department offers graduate work leading to the Ph.D. degree. Specialization is possible in molecular virology, viral oncology, cell biology, microbial physiology, immunochemistry, immunogenetics, cancer immunology, and general immunology.

Undergraduate preparation in biochemistry and physical chemistry is required. A brochure describing the Ph.D. degree program, prerequisites for admission, and research in the department can be obtained by writing the Director of Graduate Studies, Box 3020, Duke Medical Center.

212, 213. **Research Techniques in microbiology and immunology.** An introduction to biochemical, immunologic, and cell culture techniques with emphasis

on approaches to contemporary problems in molecular and cellular biology. Prerequisite: Biochemistry 248 or equivalent. Open only to graduate students in Microbiology and Immunology. Offered only in the summer. 2 units. *Dawson, Vanaman, or Staff*

**219. Molecular and Cellular Basis of Development.** See course description for Anatomy 219. (Also listed as Anatomy 219, Biochemistry 219, Pathology 219, and Physiology 230.) 3 units. *Counce or Staff*

**219S. Seminar.** Optional seminar offered in conjunction with Microbiology 219.

**221. Medical Microbiology.** An intensive study of common bacteria, viruses, fungi, and parasites which cause disease in man. The didactic portion of the course focuses on the nature and biological properties of microorganisms causing disease, the manner of their multiplication, and their interaction with the entire host as well as specific organs and cells. 4 units. *Joklik or Staff*

**233. Microbiology.** Introduction to bacteriology, virology, cell biology, and immunology. Structure, metabolism and growth of bacteria, the properties of bacterial and animal viruses, and basic immunology. (Also listed as Botany 233.) 3 units. *Burns, Dawson, Joklik, or Willett*

**242. Mechanisms of Microbial Pathogenicity.** A lecture-seminar course on the principles and problems of host-parasite interactions at the cellular and molecular level. Emphasis will be on the roles of microbial structures and products in the virulence and pathogenesis of acute, chronic, and toxigenic infectious disease systems. Prerequisites: Biochemistry 248 and Microbiology 233, or equivalents. 2 units. *Wheat*

**252. General Virology and Viral Oncology.** The first half will be a discussion of the structure and replication of mammalian and bacterial viruses with special emphasis on the molecular and functional aspects. A second part will deal specifically with tumor viruses, discussed in terms of the virus-cell interaction and the response to the host. The relationship of virus infection to neoplasia will be emphasized. 4 units. *Joklik, Smith, or Zweerink*

**282. Molecular Microbiology.** Structure, growth, and replication of bacteria with a detailed analysis of informational and catalytic macromolecules. Major topics discussed are: biochemistry and function of structural components, genetic and metabolic regulatory mechanism, RNA and protein synthesis, and the enzymology of DNA replication. Prerequisite: general biochemistry. 4 units. *Burns, Leis, or Vanaman*

**291. Basic Immunology.** Structure and function of immunoglobulins. Characteristics of synthetic and natural antigens. Specificity and cross-reactivity. Methods of immunologic analysis. Cellular aspects and kinetics of antibody formation. Forms of immunologic responsiveness and unresponsiveness. Cellular cooperation. Elicitation and control of immune responses. 3 units. *Amos, Dawson, Koren, Scott, or Snyderman*

**296. Immunochemistry.** The structures, bioassembly, and reactions of the immunoglobulins. Primary and conformational aspects of the immunoglobulin chains—sequences, subgroups, domains, allotypes, evolution. The antibody binding site—location, specificity, idiotypes, antigen accommodation. Affinity, heterogeneity, homogeneous binding, kinetics. Sequential, conformational, and quaternary determinants. Active centers of multivalent antigens. The immune responses, affinity and immunoselection, T and B cells. 3 units. *Cresswell, Dawson, Day, or Sage*

## For Graduates

**323. Readings in Bacteriology and Immunology.** A course of readings and syntheses in restricted areas of bacteriology and immunology under the direction of individual staff members. 2 units. *Staff*

**325. Medical Mycology.** Comprehensive lecture and laboratory coverage of all the fungi pathogenic for humans. Practical aspects as well as future trends in the mycology, immunology, diagnosis, pathogenesis, and epidemiology of each mycotic agent will be explored. There will be several invited lecturers, each an internationally recognized scientist, discussing their particular areas of mycological expertise and current research. Prerequisite: consent of instructor. 4 units. *Mitchell*

**330. Medical Immunology.** A course designed to present the basic concepts of immunology as they relate to human disease. Emphasis will be on tumor immunology, autoimmunity, neuroimmunology, immunohematology, and immunologic deficiency diseases. 6 units. *Levy or Staff*

**331.1-331.8. Microbiology Seminar.** Current topics in microbiology with seminars presented by students, faculty, and outside speakers. Required course for all students specializing in microbiology. 1 unit each semester. *Staff*

**332.1-332.8. Immunology Seminar.** Current topics in immunology with seminars presented by students, faculty, and outside speakers. Required course for all students specializing in immunology. 1 unit each semester. *Staff*

**336. Immunogenetics.** Antigens of tissues and organs, distribution, extraction, and chemistry. Phylogeny of iso-antigenic systems of man and animals. Tests for histocompatibility including lymphocyte interactions and reactivity. Change in antigenicity and immune responsiveness in carcinogenesis. Immunologic factors in pregnancy and in homotransplantation of organs. (Also listed under the University Program in Genetics.) 2 units. *Amos or Ward*

**420. Cellular Immunophysiology.** See course description for Physiology 420. (Also listed as Physiology 420.) 2 units. *Lauf or Staff*

## Pathology

Professor Jennings, *Chairman* (301B Davison); Professor Sommer, *Director of Graduate Studies* (301 Davison); Professors Fetter, Hackel, Johnston, Kinney, Klintworth, Pratt, Vogel, and Wittels; Associate Professors Adams, Bigner, Bossen, Bradford, Daniels, Elchlepp, Tisher and Zwadyk; Assistant Professors Anderson, Burger, Graham, Hawkins, Reimer, Shelburne, and Vollmer

The Department of Pathology offers graduate work leading to the M.S. and Ph.D. degrees with areas of specialization such as subcellular and molecular pathology. Course work is designed to give a broad background in classical and modern pathology with emphasis on the application of modern research techniques. Students will be required to take such courses as are necessary to obtain a broad foundation, as well as courses applicable to areas of speciality and research. Further information including brochures giving details of departmental facilities, staff, trainee stipends, and the M.D.-Ph.D. program are available from the Director of Graduate Studies.

**219. Molecular and Cellular Basis of Development.** For a description of the course see Anatomy 219. (Also listed as Anatomy 219, Biochemistry 219, Microbiology 219, and Physiology 230.) 3 units. *Counce, McCarty, and Staff*

**219S. Seminar.** Optional seminar offered in conjunction with Pathology 219.



**250. General Pathology.** The fundamentals of pathology are presented to the student. Lectures developing broad concepts of disease processes are given by the members of the senior staff. The emphasis is placed on etiology and pathogenesis of disease. Lectures. Prerequisites: histology and consent of instructor. 4 units. *Jennings and Staff*

**251. Laboratory Course in General Pathology.** Laboratory session to complement 250. Gross and microscopic material is correlated with and related to disease processes. Pathology 250 may be taken concurrently. Prerequisites: histology and consent of instructor. 4 units. *Jennings and Staff*

**258. Cellular and Subcellular Pathology.** This course is designed for students wishing to broaden their knowledge of cellular structure and cellular pathology. The course consists of lectures and seminars discussing the alterations in cellular structure and associated functions that accompany cell injury. Prerequisite: consent of instructor. Fall only. Hours to be arranged. 3 units. *Hawkins, Jennings, Reimer, Shelburne, and Sommer*

**275. Fundamentals of Electron Microscopy.** Theoretical basis of practical electron microscopy. Areas to be discussed include the nature of light and electrons, light and electron optics, image recording and processing by photographic and other methods, specimen preparation, functional anatomy of the electron microscope, and several special techniques. Student presentations and selection of special topics will be encouraged. The approach will be non-mathematical, but college physics is strongly recommended. Practical laboratory experience will be included. Fall only. 2 units. *Hawkins, Shelburne, or Sommer*

**325. Cardiovascular Pathology.** Cardiovascular disease processes will be studied, reviewing anatomic, embryologic, and physiologic features, and utilizing case material and gross specimens. Consideration will be given to principles of electrocardiography. Fall only. 3 units. *Hackel, Jennings, and Rimer*

**352. Basic Problems in Chemical Pathology.** This is an advanced seminar tutorial course in which the biochemical and physiological expressions of morphologic abnormalities will be explored. Specific organ systems will be used as a model for instruction and discussion. Experimental approaches toward solutions of problems will be discussed. Prerequisite: consent of instructor. 2 units. *Wittels*

**353. Advanced Neuropathology.** This course deals with current problems and research methods related to diseases which affect the nervous system. Prerequisite: consent of instructor. Fall only. 2 units. *Vogel*

**355, 356. Graduate Seminar in Pathology.** Discussions outlining the scope of modern pathology. This will include reports of original researchers by members of staff and visitors. Hours to be arranged. 1 unit each semester. *Sommer and Staff*

**357. Research in Pathology.** Independent research projects in various fields of pathology. Hours and credit to be arranged. *Jennings and Staff*

**360. Cytochemistry.** Theory and application of cytochemical techniques for investigating the presence and localization in cells of various substances such as proteins, lipids, carbohydrates, and enzymes at the light and or electron microscopic level, including radioautography. Student will get some laboratory experience. Maximum enrollment six. Spring only. 3 units. *Hawkins and Sommer*

**361, 362. Autopsy Pathology.** A detailed consideration of the morphologic, physiologic, and biochemical manifestations of disease. Emphasis is on individual work in the laboratory with tutorial supervision. Gross dissection, histologic examination, processing, and analyzing or morphologic, microbiologic, and biochemical

data, and interpretation of results. For advanced students. Prerequisites: Pathology 250 and consent of instructor. 3 to 6 units each semester. *Adams and Staff*

**364. Systemic Pathology.** Systematic presentation of the characteristics of disease processes as they affect specific organ systems. 6 units. *Hackel and Staff*

**367, 368. Special Topics in Pathology.** Special problems in pathology will be studied with a member of the senior staff; the subject matter will be individually arranged. Hours to be arranged. 2 to 4 units. *Jennings and Staff*

**369. Ophthalmic Pathology.** This course will consist of lectures, seminars, and laboratory sessions. The normal anatomy and embryology of the eye will be reviewed as a basis for the study of the various ocular disease processes. The more common diseases of the eye will be considered in detail. Problems in ophthalmic pathology will be discussed together with methods of solving them. Fall only. 3 units. *Klintworth*

**370. Developmental Pathology and Teratology.** A systematic study of disease processes involving the prenatal, natal, and postnatal period. Emphasis will be placed on developmental anatomy and teratogenesis. The format includes seminars and clinicopathologic correlations derived from gross and microscopic material. Prerequisites: Pathology 350, anatomy, and histology. Spring only. 3 units. *Bradford*

**373. Cytopathology.** This course is designed to present the principles and techniques by which basic cytology is applied to the diagnostic interpretation of disease. Classroom and laboratory work will include diseases involving the female genital tract, respiratory tract, urinary tract, effusions, gastrointestinal tract, and central nervous system. Neoplastic disease will be emphasized. Practical application of the acquired knowledge will be made in examining current material. Prerequisites: Pathology 350, 351, or consent of instructor. Fall. 3 units. *Johnston and Staff*

**374. Pulmonary Pathology and Postmortem Pathophysiology.** Emphasis will be on pulmonary pathology and pathophysiology of infectious, metabolic, environmental, and neoplastic diseases, and certain diseases of unknown etiology (e.g., sarcoid, alveolar proteinosis, etc.). Ventilatory experiments will be done on excised human lungs. Fall. 3 units. *Pratt*

**377. Pathology of the Kidney.** The course includes a comprehensive study of pathological, immunological, and clinical features of the glomerulonephritis, and pyelonephritis, as well as of metabolic, congenital, and neoplastic renal disorders. Lectures will be supplemented with gross and microscopic specimens, demonstrations, and special library studies. Fall. 3 units. *Tisher*

**378. Immunopathology.** A study of human diseases in which the immune system plays an important role. A series of lectures, seminars, and studies of human case materials. Spring. 2 units. *Adams, Bigner, Bossen, or Daniels*

**379. Pathology of Virus Infections.** The pathological effects of viruses will be discussed. A series of lectures and student-conducted seminars concerning the structural, biochemical, and functional alterations associated with virus-cell interactions. Prerequisites: Pathology 250 and 251. Fall. 4 units. *Daniels*

## Philosophy

Professor Golding, *Chairman* (201E West Duke); Associate Professor Roberts, *Director of Graduate Studies* (201B West Duke); Professors Peach and Welsh; Associ-

ate Professors Mahoney and Sanford; Assistant Professor Ross; Visiting Assistant Professors Bamford and Boudreaux

The Department of Philosophy offers graduate work leading to the A.M. and Ph.D. degrees. Tutorial work complements formal instruction. Students may specialize in any of the following fields: the history of philosophy, logic, philosophy of science, epistemology, metaphysics, philosophy of mind, philosophical analysis, ethics, aesthetics, political philosophy, philosophy of law, philosophy of medicine, and philosophy of religion.

Individual programs of study are developed for each student. The following requirements, however, are fundamental: (1) In February of their first year new graduate students are required to take one or two qualifying examinations, diagnostic in purpose. One examination tests ability to deal critically and systematically with some basic philosophical topic; a second examination, in logic, is required of anyone who has not taken a graduate-level logic course during the first term. (2) The preliminary examination for the Ph.D., which may be taken only after a student has met the language requirement for that degree, should be taken after the second year of study. In these examinations students are expected to combine historical knowledge with critical understanding.

Work in a minor or related field, not necessarily confined to any one department, is encouraged but not required. A minor normally includes 6 units for the A.M. or the Ph.D. degree and may include more as a student's program requires or permits.

A student who meets the general requirements of the Graduate School for the A.M. degree may earn this degree by satisfying the foreign language requirement and by passing the preliminary examination for the Ph.D. degree or by writing and successfully defending a master's thesis.

A reading knowledge of at least one foreign language, ancient or modern, is required for the Ph.D. degree. Students may not take their preliminary examinations until they have demonstrated this ability. More than one language may be required where this is judged appropriate to the research demanded by the candidate's dissertation.

## For Seniors and Graduates

**202. Aesthetics: The Philosophy of Art.** A study of some fundamental issues in aesthetics with particular reference to the fields of literature, music, and painting. Problems discussed include the role of standards in criticism, aesthetic judgment, interpretation, evaluation in the arts, meaning in the arts, art and truth, the arts and morality. Open to juniors with the consent of the instructor. 3 units. *Welsh*

**203. Contemporary Ethical Theories.** Study of the nature and justification of basic ethical concepts in the light of the chief ethical theories of twentieth-century British and American philosophers. 3 units. *Roberts*

**204. Philosophy of Law.** Natural law theory and positivism; the idea of obligation (legal, political, social, moral); and the relation of law and morality. 3 units. *Golding*

**205. Philosophy of History.** The nature of historical knowledge and inquiry; theories of the historical process. 3 units. *Staff*

**206. Topics in Ethical Theory.** 3 units. *Staff*

**208. Political Values.** Analysis of the systematic justification of political principles and the political values in the administration of law. 3 units. *Golding*

**211. Plato.** A critical study of selected dialogues, with emphasis on problems in epistemology and metaphysics. 3 units. *Mahoney*

**217. Aristotle.** A study of passages from the *Organon*, *Physics*, *De Anima*, and *Metaphysics*. 3 units. *Mahoney*

**218. Medieval Philosophy.** Selected problems in medieval philosophy. 3 units. *Mahoney*

**225. British Empiricism.** A critical study of the writings of Locke, Berkeley, or Hume with special emphasis on problems in the theory of knowledge. 3 units. *Peach*

**227. Continental Rationalism.** A critical study of the writings of Descartes, Spinoza, or Leibniz with special emphasis on problems in the theory of knowledge and metaphysics. 3 units. *Peach*

**228. Recent and Contemporary Philosophy.** A critical study of some contemporary movements in philosophy with special emphasis on the work of Moore, Russell, Wittgenstein, Wisdom, and Ryle. 3 units. *Welsh*

**230. The Meaning of Religious Language.** See course description for Religion 230. (Also listed as Religion 230.) 3 units. *Poteat*

**231. Kant's Critique of Pure Reason.** 3 units. *Staff*

**232. Recent Continental Philosophy.** Selected topics. 3 units. *Staff*

**233. Methodology of the Empirical Sciences.** Recent philosophical discussion of the concept of a scientific explanation, the nature of laws, theory and observation, probability and induction, and other topics. Prerequisite: consent of instructor. 3 units. *Ross*

**234. Problems in the Philosophy of Science.** Selected problems in the physical and nonphysical sciences such as space and time, measurement and determinism. Prerequisite: consent of instructor. 3 units. *Ross*

**241. Symbolic Logic.** Detailed analysis of deduction and of deductive systems. 3 units. *Staff*

**251. Epistemology.** Selected topics in the theory of knowledge, e.g., conditions of knowledge, scepticism, and certainty, perception, memory, knowledge of other minds, and knowledge of necessary truths. 3 units. *Sanford*

**252. Metaphysics.** Selected topics: substance, qualities and universals, identity, space, time, causation, and determinism. 3 units. *Sanford*

**253. Philosophy of Mind.** Analysis of concepts such as thought and belief; issues such as mind-body relations, thought and action, the nature of persons and personal identity. 3 units. *Roberts*

**254. Philosophy of Religion.** Topics such as proofs of the existence of God, meaningfulness of religious language, the problems of evil, immortality, and resurrection. 3 units. *Roberts*

**255. Philosophy of Action.** Problems in the individuation, characterization, and explanation of human actions; an analysis of such concepts as choosing, deciding, intending, doing, making, letting. 3 units. *Sanford*

**260. Wittgenstein.** An examination of the *Tractatus* or the *Investigations*. 3 units. *Welsh*



287, 288. **Foundations of Mathematics.** See course description for Mathematics 287, 288. (Also listed as Mathematics 287, 288.) 3 units. *Shoenfield*

291, 292. **Seminar in Special Fields of Philosophy.** 3 units. *Graduate Staff*

For Graduates

331, 332. **Seminar in Special Fields of Philosophy.** 3 units. *Graduate Staff*

## Physical Therapy

Professor Bartlett, *Chairman* (045 Hospital); Associate Professor Branch, *Director of Graduate Studies* (045 Hospital); Associate Professor Villanueva; Assistant Professors Eckel and Horton; Associates Cannon, George, Huse, Stafford, and Zeitschel; Adjunct Assistant Professor Roses

The Department of Physical Therapy offers a basic professional program leading to the M.S. degree. To be eligible for admission to the program, applicants must have obtained a baccalaureate degree and have a background in the basic sciences and social sciences including course work in biology, chemistry, physics, psychology, and statistics. In the first year of the curriculum students are required to take courses in anatomy and physiology, offered by those respective departments. Further information may be obtained from the Director of Graduate Studies, Department of Physical Therapy, Box 3965, Duke University Medical Center, Durham, N.C. 27710.

**201, 202. Seminar in Physical Therapy.** Historical background and trends in the profession; orientation to physical therapy departmental organization and administration; professional and community relationships; professional ethics; methods of communication; and literature review. Units by arrangement. *Bartlett*

**217. Physical Therapy Dynamics I.** Orientation to patient care; principles of biomechanics and applied anatomy; introduction to microscopic anatomy. 3 to 4 units. *Branch, Villanueva, and Eckel*

**218. Physical Therapy Dynamics II.** Regional approach to the process of human movement analysis, including kinesiological analysis of normal and pathological patterns of gait; introduction to therapeutic exercise, with emphasis on rationale and methods of treatment; principles and practice of physical therapy procedures, with emphasis on biophysical and physiological considerations for utilization of selected therapeutic agents: mechanical, thermal, chemical, and electrical. 3-5 units. *Villanueva and Staff*

**220. Physical Therapy Dynamics III.** The role of the central nervous system in the inhibition or facilitation of motor behavior as related to the management of patients with central nervous system disorders. Emphasis on the application of current neurophysiological concepts to the evaluation of patients with central nervous system deficits and to the planning and administration of treatment programs. 2 to 4 units. *Cannon*

**230, 231. Physical Evaluation and Instrumentation.** Principles and techniques of objective assessment and analysis of functional status, including manual muscle tests, dynamometry, goniometry, electrical diagnostic testing, posture analysis, body measurements, evaluation of respiratory and sensory function, disability evaluation, and orientation to electromyography and nerve conduction studies. 2 to 4 units. *Villanueva and Staff*

**234. Introductory Pathology.** Fundamentals of pathology with emphasis on broad concepts of disease processes; systems of the body are studied from the

point of view of histological and functional change. 2 to 3 units. *Branch and Special Lecturers*

**236. Medical Sciences.** Lectures by clinicians with patient demonstrations and correlation of treatment methods; medical and surgical, neurological, orthopaedic, and emotional conditions affecting human dysfunction; emphasis on psychodynamic principles of patient-therapist relationships. 4 units. *Staff and Special Lecturers*

**238. Introduction to Health Service Systems.** Political, economic, and sociocultural aspects of the organization of health care systems; structural components and interrelationships; criteria for assessing and analyzing health care systems. 2 to 3 units. *Staff*

**240. Prosthetics and Orthotics.** Designed to provide basic knowledge of the effects of prostheses and orthoses on trunk and extremity function, in relation to various skeletal and neuromuscular disorders. Includes components and materials; design and fabrication; principles of fit, alignment and operation of device; evaluation; gait and activities training procedures. 2 to 4 units. *Villanueva and Staff*

**242. Directed Clinical Experience in Physical Therapy I.** Students are assigned to hospitals, rehabilitation centers, schools for crippled children, extended-care facilities, and public health units for short-term supervised learning experiences. 1 to 2 units. *Staff*

**243, 244. Directed Clinical Experience in Physical Therapy II.** Students are assigned to full-time learning experiences under direction. 2 to 4 units each semester. *Staff*

**297, 298. Special Topics in Physical Therapy.** Special problems in physical therapy will be studied with a faculty member; the subject matter will be individually arranged. Units to be arranged. *Staff*

**301. Introduction to Scientific Inquiry.** Theory and use of analytical methods of problem-solving; elements of scientific writing; preparation of a research protocol and a major paper. 3 units. *George*

**315. Curriculum Development.** Introduction to learning theory; development of objectives, organization, course content, and evaluation in physical therapy education. 2 to 3 units. *Staff*

**316. Directed Teaching in Physical Therapy.** 1 to 3 units. *Staff*

**332. Administration of Physical Therapy Services.** Principles of administration, leadership styles, and management roles; concepts of systems theory and analysis; planning, organizing, delivering, and evaluating physical therapy systems and subsystems. 3 units. *Staff*

**350. Research.** Units by arrangement. *Staff*

## Physics

Professor Walker, *Chairman* (119 Physics); Associate Professor Evans, *Director of Graduate Studies* (111 Physics); Professors Biedenharn, Bilpuch, Fairbank, Gordy, Lewis, Meyer, Newson, Roberson, Robinson, and Walter; Adjunct Professors O'Foghluha, Robl and Way; Associate Professors Cusson, DeLucia, Fortney, Han; Assistant Professors Friedman, Goshaw, Lawson, Lisowski, Loos, and Smith

The Department of Physics offers graduate work for students wishing to earn the A.M. or Ph.D. degree. In addition to a balanced program of basic graduate

courses, the department offers specialized courses and seminars in several fields, in which research is being done by students, faculty, and staff.

With the help of faculty advisers, students select a course program to fit their needs, including work in a related field, usually mathematics or chemistry. Students are encouraged to begin research work early in their careers.

The department does not ordinarily accept students for work toward the A.M. degree only, and students making good progress are advised to work directly for the Ph.D. degree. The option of taking the A.M. without thesis is available with the approval of a departmental committee.

A reading knowledge of one language, usually chosen from French, German, or Russian, is required for the Ph.D. degree.

### For Seniors and Graduates

**211, 212. Advanced Modern Physics.** Quantum theory with applications to the study of atoms, molecules, solids, and nuclei. Prerequisites: Physics 161 and 181, or equivalents; Mathematics 285 and 286, or equivalents (may be taken concurrently). 6 units. *Robinson*

**215. Introduction to Quantum Mechanics.** Wave mechanics and elementary applications; the hydrogen-like atoms; electron spin and angular momentum; operators and eigenvalues; stationary state perturbation theory; identical particles. Prerequisites: courses in modern physics and intermediate mechanics, and Mathematics 285 and 286 (may be taken concurrently). 3 units. *Evans*

**217S, 218S. Advanced Physics Laboratory and Seminar.** Experiments involving the fields of mechanics, electricity, magnetism, heat, optics, and modern physics. 6 units. *Meyer*

**220. Electronics.** Basic elements of modern electronics including a.c. circuits, transfer functions, solid state service, transistor circuits, operational amplifier applications, digital circuits, and computer interfaces. 3 units. *Fortney*

**223. Electricity and Magnetism.** Electrostatic fields and potentials, boundary value problems, magnetic induction, energy in electromagnetic fields, Maxwell's equations, introduction to electromagnetic radiation. 3 units. *Loos*

**268. Mathematical Foundations of General Relativity.** (Also listed as Mathematics 268.) 3 units. *Cantor*

**280. Nuclear Reactor Physics.** Neutron diffusion theory, reactor criticality, kinetics, control, and reactivity effects. Slowing-down of neutrons, age theory, resonance absorption, temperature effects, and multigroup methods. Prerequisites: Physics 161; Mathematics 285 and 286, or equivalents (may be taken concurrently). 3 units. *Cusson*

**282. Mechanics of Continuous Media.** Small vibrations, rigid body motion, hydrodynamics, elasticity. Prerequisites: Physics 41 and 42, or 51 and 52; differential and integral calculus. 3 units. *Walker*

### For Graduates

**302. Advanced Mechanics.** The fundamental principles of Newtonian mechanics; general dynamics of systems of particles and rigid bodies; the methods of Lagrange and Hamilton; generalized mechanics. 3 units. *Cusson*

**303. Statistical Mechanics.** Fundamental laws of thermodynamics and statistical mechanics with applications to physics and chemistry. Classical and quantum

ideal gases; approximate methods for real gases and liquids. Prerequisite: Physics 215. 3 units. *Friedman*

**304. Advanced Topics in Statistical Mechanics.\*** This course will vary from year to year. Possible topics include Fermi liquids, systems of bosons, many-body theory, non-equilibrium statistical mechanics. Prerequisites: Physics 303 and 316. 3 units.

**305. Introduction to Nuclear Physics.** Phenomenological aspects of nuclear physics; interaction of gamma radiation and charged particles with matter; nuclear detectors; particle accelerators; radioactivity; basic properties of nuclei; nuclear systematics; nuclear reactions, particle scattering; nuclear models of the deuteron; nuclear forces; parity. 3 units. *Roberson*

**306. Low Temperature Physics.\*** The properties of matter near the absolute zero of temperature; superconductivity, liquid helium, adiabatic demagnetization. Prerequisite: Physics 303. 3 units. *Fairbank*

**308. Introduction to High Energy Physics.** High energy processes; electromagnetic, weak, and strong interactions. 3 units. *Walker*

**309. Solid State Physics I.** Properties of matter in the condensed state; crystal lattices, electrons in metals and semiconductors, band theory, nonmetallic solids, lattice dynamics, and phonons. Prerequisites: Physics 215 and 303. 3 units.

**310. Solid State Physics II.\*** Elementary excitations and their interactions in the condensed state of matter; scattering theory and correlation functions; magnetic interactions in solids, superconductivity; amorphous solids. Prerequisites: Physics 309 and 316. 3 units.

**312. Phase Transitions and Critical Phenomena.** Description of phase transitions in diverse physical systems such as fluids, magnets, mixtures, and superfluids. Experimental techniques and results. Application of the classical methods of thermodynamics, correlation functions, and mean field theory to the critical state of matter. Microscopic models of phase transitions. Modern approaches to static and dynamic critical phenomena such as the theories of critical exponents, scaling, series expansions, critical relaxation, and mode-mode coupling. 3 units.

**316. Principles of Quantum Theory.** Original and fundamental concepts of quantum theory; wave and matrix mechanics; theory of measurements; exclusion principle and electronic spin. Prerequisite: Physics 302. 3 units. *Evans*

**317. Intermediate Quantum Theory.** General operator methods; angular momentum; Dirac electron theory. Second quantization; symmetry principles and conservation theorems. Applications to the theory of solids, of nuclei, and of elementary particles will be stressed. Prerequisite: Physics 316. 3 units. *Biedenharn*

**318. Electromagnetic Field Theory.** Electrodynamics; theory of wave optics; radiation of electric and magnetic multipole fields; special relativity; covariant electrodynamics; Lienard-Wiechert potentials; scattering and dispersion; Hamiltonian field equations. Prerequisite: Physics 223. 3 units each semester.

**330. Nuclear Structure Theory.\*** Two body nuclear forces used to describe nuclear structure; nuclear shell and collective models; properties of nuclear levels; magnetic and quadrupole moments; transition probabilities; nucleon-nucleon scattering; nuclear reactions. Prerequisites: Physics 305 and 316. 3 units.

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\*Offered on demand.



**331. Microwave Radiation.\*** Microwave generators, cavity resonators, transmission lines, radiation propagation, and detection. 3 units. *Gordy*

**335. Microwave Spectroscopy.\*** Application of microwaves in the determination of molecular, atomic, and nuclear properties. Stark and Zeeman effects in microwave spectroscopy. Magnetic resonance absorption. 3 units. *Gordy*

**341. Advanced Topics in Quantum Theory.\*** Introduction to relativistic quantum field theory; Lorentz and Poincare groups; quantization of free fields; interacting fields and S-matrix; applications of quantum electrodynamics and dispersion relations. Prerequisite: Physics 317. 3 units.

**342. Theory of Elementary Particles.\*** Theoretical methods used in treating particle interactions, emphasizing phenomenological treatments. Quantum field theory and dispersion theory is developed as needed. Applications in the general areas of pion physics, electromagnetic interactions of hadrons, strange particle interactions, and weak interactions are surveyed. Prerequisite: Physics 316. 3 units. *Han*

**343. Nuclear Physics.\*** Elementary theory of the deuteron; low energy neutron-proton scattering; theory of nuclear reactions; penetration of potential barriers; nuclear energy levels. Prerequisite: Physics 215. 3 units. *Newson*

**344. Advanced Nuclear Physics.\*** The deuteron, nuclear forces, scattering of elementary particles, beta-radiation. Other aspects of nuclear physics amenable to theoretical interpretation. 3 units. *Biedenharn*

**345. High Energy Physics.\*** Experimental and theoretical aspects of high energy nuclear processes; properties of mesons and hyperons. 3 units.

**346. Topics in Theoretical Physics.\*** The content of this course will vary from year to year. General methods in quantum mechanics such as group theory and its applications; elementary particle theory; field theory; theory of solids; theoretical nuclear physics; atomic and molecular structure. Prerequisites: Physics 316 and 317. 3 units.

**351, 352. Seminar.** A series of weekly discussions on topics related to the research projects under investigation in the department. 2 to 4 units. *Graduate Staff*

**397, 398. Low Temperature and Solid State Seminar.** Weekly seminar on advanced topics and recent research work in the field of low temperature and solid state physics. 2 to 4 units.

## Physiology and Pharmacology

Associate Professor Salzano, *Acting Chairman* (388 Nanaline H. Duke); Professor Ottolenghi, *Director of Graduate Studies* (425 Nanaline H. Duke); Professors Bernheim, Blum, Hitchings, Jöbsis, Johnson, Lack, Maxwell, Moore, Narahashi, Nichol, Schanberg, and Somjen; Associate Professors Anderson, Bennett, Gutknecht, Kylstra, Lauf, Lieberman, McManus, Mendell, Menzel, Mills, Padilla, Posner, Slotkin, Spach, and Wolbarsht; Assistant Professors Carter, Ellinwood, Greenfield, Hall, Lebovitz, Mandel, Namm, Rosen, Rosenthal, Schomberg, Schooler, Strauss, Wachtel, and Wallace; Assistant Medical Research Professors Abou-Donia, Duran, McHale, Ramon, Simon, Wu, and Yeh; Associate Wilson

The Department of Physiology and Pharmacology offers graduate work leading to the Ph.D. degree. Before undertaking this program a student should have a strong background in basic sciences including course work in mathematics, biology, physics, and chemistry through physical chemistry. Undergraduates with this

background may have majors in any of the following areas: biology, chemistry, physics, or engineering. There is no foreign language requirement. All graduate students are required to take the introductory courses in both physiology and pharmacology. A brochure which describes the program of study, facilities, and research activities of the staff is available from the Director of Graduate Studies.

### For Seniors and Graduates

**200. Introduction to the Physiology of Man.** Lectures and conferences on cell and organ physiology. Human and medical aspects are stressed in clinical conferences and in laboratory experience. The neurophysiology section is given in a three-week period following the end of the semester. Limited to students whose training requires knowledge of human physiology as it pertains to medicine. Three lectures, two conferences and one laboratory per week. Prerequisite: consent of course leader. Fall. 7 units. *Jöbsis and Staff*

**204. Introduction to Modern Physiology.** Topics such as flow of fluids in tubes, ionic transport mechanisms, and endocrine systems are examined in terms of how such processes enter into the functioning of intact organs such as heart, lung, gut and central nervous system. Particular emphasis is given to the control of physiological function both at the cellular and higher levels of organization. Required of all graduate students in physiology and pharmacology. Others must have consent of instructor. Prerequisites: at least one year each of physics, calculus, and biology; chemistry through organic chemistry; physical chemistry is strongly recommended. Fall. 4 units. *Blum or Staff*

**208. Respiratory System in Health and Disease.** Primary emphasis on the physiology of respiration. Topics include pulmonary mechanics, gas exchange, ventilation-perfusion relationships, central and peripheral regulation of ventilation and respiratory responses to exercise, altitude, and hyperbaric environments. Spring. 2 units. *Salzano and Kylstra*

**210, 211. Individual Study and Research.** Directed reading and research in physiology and pharmacology. Prerequisites: senior standing and consent of the Director of Graduate Studies. Fall and spring. 3 to 9 units each semester. *Staff*

**212. Membrane Physiology and Osmoregulation.** Physiology of marine and estuarine organisms, with emphasis on cellular transport and electrophysiology. Includes the functions, mechanisms, and comparative aspects of ionic and osmotic regulation in aquatic plants and animals. Laboratory work deals with membrane transport in single cells and epithelia, renal and gill transport in fish, amino acid transport and metabolism in crustaceans, and application of radiotracer and other physical and chemical techniques to the study of membrane function. Prerequisite: consent of instructor. Summer. 6 units. *Gutknecht and Staff*

**215. Topics in Developmental Physiology.** The physiological basis of development at the organ level with special reference to vertebrates. Development of neuronal connections, cardiogenesis, hormonal regulation and cellular interactions in organogenesis. Prerequisite: consent of instructor. Alternate years beginning spring, 1977. 2 units. *Lieberman, Mendell, or Padilla*

**216. Contractile Processes.** Cellular basis of activity in cilia and skeletal, cardiac, and smooth muscle; submicroscopic structure and behavior of muscle; special properties of muscle membranes; the problem of electro-mechanical coupling; mechanics, thermodynamics, and biochemistry of muscular contraction; developmental and adaptive changes in function. Prerequisite: consent of instructor. Alternate

years beginning fall, 1978. (Also listed as Anatomy 215.) 3 units. *Anderson, Jöbsis, Johnson, or Reedy*

**217. Membrane Transport.** Chemical composition and ultrastructure of biological membranes, ionic and osmotic equilibria across the membranes of individual cells, passive and active ionic transport, the role of ATPase, carrier-mediated diffusion of non-electrolytes, integration of transport processes to produce molecular movements across organized epithelia, e.g. amphibian skin and bladder, and gastrointestinal mucosa. Prerequisite: consent of instructor. Fall 3 units. *Hall, Lauf, Mandel, or Simon*

**220. Physiology of Exercise.** Physiological principles of organ systems involved in physical exercise. Physiological limits in normal health; selected pathological states; illustrative aspects of physical therapy. For students of physical therapy. Not recommended for students who have taken Physiology 200, 202, or equivalent. Prerequisites: an undergraduate course in organ physiology and consent of instructor. Spring. 2 units. *Jöbsis and Staff*

**222. Marine Electrobiology.** The physiology and behavioral consequences of bioelectric activity ranging from the cell membrane to the interanimal communication level. Laboratory work deals with bioelectric recording and stimulation techniques with particular emphasis placed on electrophysiological studies of marine organisms wherein cellular correlates of animal behavior are clearly seen. Ionic basis of bioelectric signals, transmission of signals within and between cells, relation of bioelectric signals to particular behavioral patterns, effects of externally applied electric fields, bioelectric communication and navigation systems. Prerequisite: consent of instructor. Summer. Given at Beaufort. (Also listed as Biomedical Engineering 252.) 6 units. *Wachtel and Wolbarsht*

**225. An Introduction to Neuronal Physiology and Pharmacology.** The properties of excitable membranes in qualitative terms, including impulse generation and conduction in different types of nerves, the effects of pharmacological agents on electrical properties of membranes, the physiological and pharmacological aspects of synaptic and neuromuscular transmission, and biophysics of receptor cells. Electrophysiological techniques are presented in Physiology 386 which supplements this course. Advanced quantitative approaches to membrane biophysics including voltage clamp techniques are covered in Physiology 416. Fall. 3 units. *Narahashi, Moore, Wachtel, or Wolbarsht*

**230. Molecular and Cellular Basis of Development.** See course description for Anatomy 219. (Also listed as Anatomy 219, Biochemistry 219, Microbiology 219, and Pathology 219.) Fall. *Counce, Johnson, Kaufman, McCarty, or Padilla*

**230S. Seminar.** Optional seminar offered in conjunction with Physiology 230.

**250. Pharmacology: Mode of Action of Drugs.** The pharmacological action of drugs in terms of biochemical and physiological processes. Three lectures and one conference per week. Prerequisite: Physiology 200 or equivalent. Spring. 4 units. *Menzel or Staff*

**252. Cellular and Chemical Pharmacology.** Chemical aspects of cell-drug interaction and structure-activity relationships. Stereochemistry. Cholinergic and adrenergic mechanisms. Drug design. Alternate years beginning fall, 1977. 3 units. *Ottolenghi or Staff*

**254. Mammalian Toxicology.** Principles of toxicology as related to man. Emphasis on the molecular basis for toxicity of chemical and physical agents. Subjects include the limitations and assumptions of extrapolation to man from animal tox-

icity, safety drugs and food additives, toxicity of pesticides and their hazard to man, and the role of scientists in societal decisions on the use of man-made chemical and physical agents. Prerequisite: consent of instructor. Fall. 3 units. *Menzel or Staff*

**256. Human Nutrition.** Nutrition principles with emphasis on physiology and pharmacology. Topics include the chemical basis for nutrient requirements, application to practical diets, parenteral nutrition, influence of dietary intake on disease (cardiovascular disease, diabetes, and inborn errors of metabolism), optimal dietary intake, impact of food technology on human nutrition, growth, maturation, and lactation and their requirements and recent advances in micronutrient requirements. Prerequisite: consent of instructor. Fall. 2 units. *Menzel*

**280. Student Seminar in Physiology and Pharmacology.** Preparation and presentation of seminars to students and faculty on topics of broad interest to physiology and pharmacology. Required of all physiology and pharmacology graduate students. Fall and spring. 2 units. *Bernheim*

**281. Teaching Methods in Physiology.** Participation with departmental staff in various teaching modes. Lectures, conferences, tutorials and preparation of self-instructional teaching materials. Available only to graduate students in the Department of Physiology and Pharmacology. Fall, spring, and summer terms. Credit to be arranged. *Staff*

**282. Teaching Methods in Pharmacology.** Participation with departmental staff in various teaching modes. Lectures, conferences, tutorials and preparation of self-instructional teaching materials. Available only to graduate students in the Department of Physiology and Pharmacology. Fall, spring, and summer terms. Credit to be arranged. *Staff*

#### For Graduates

**311. Physiological Basis of Medicine.** Clinical presentations followed by detailed examinations of the underlying physiological dysfunction. Topics include obstructions of hollow viscera, calcium and potassium homeostasis, temperature regulation, spinal cord injury, tissue oxygenation. Fall. 3 units. *Somjen or Staff*

**321. Gastrointestinal and Renal Physiology.** Mechanisms of intestinal secretion, digestion, absorption, and motility, and their control at a cellular level. Basic renal mechanisms involved in the elaboration of urine including concentrating and diluting mechanisms, hemodynamics, and regulation of acid-base balance. Spring. 3 units. *Jones and Yarger*

**330. Pharmacological Basis of Clinical Medicine.** This course consists of a detailed analysis of the mechanisms of action and rationale for use of pharmacologic agents in disease states. Fall. 4 units. *Schanberg or Staff*

**331. Laboratory Methods in Pharmacology.** Tutorial laboratory training in various fields of pharmacology including neuropharmacology, cardiovascular pharmacology, biochemical pharmacology, and biophysical pharmacology. Certain special laboratory sessions are conducted at the Wellcome Research Laboratories of the Burroughs Wellcome Company, Research Triangle Park. Prerequisite: consent of instructor. Fall and spring. 3 to 6 units. *Narahashi, Maxwell, and Staff*

**334. Pharmacodynamics.** Introduction to the fundamentals of physical processes in biological systems as they pertain to drug action. Topics include pharmacokinetics, drug absorption, distribution, metabolism and excretion, receptor theory, Hansch correlation of molecular structure with biological activity, and molecular orbital theory. Alternate years beginning fall, 1977. 3 units. *Rosen or Slotkin*



**335. Drug Receptor Theory.** Development of receptor theory from the standpoint of kinetic models; adaptation of theory to the qualitative evaluation of receptors by biochemical, physiological, and pharmacological criteria. Prediction of receptor properties. (Receptors of the autonomic nervous system and hormone responsive cells will be emphasized.) Spring only. 2 units. *Rosen*

**362. Current Topics in Cardiac Muscle Physiology.** Selected topics in the physiology and pharmacology of cardiac muscle, including general and comparative morphology and ultrastructure, cardiac electrophysiology and mechanics, and excitation-contraction coupling. Spring. 2 units. *Johnson or Staff*

**372. Research in Physiology and Pharmacology.** Laboratory investigation in various areas of physiology and pharmacology. Fall and spring. Credit to be arranged. *Staff*

**383. Physiological Instrumentation.** Electronic methods of measurement of physiological variables. The operational amplifier is used as the active building block in appropriate feedback circuits containing only passive elements to make a wide range of linear instruments including analog computers. Digital logic and computing elements are also developed. Alternate years beginning spring, 1977. 3 units. *Moore or Staff*

**386. Laboratory Methods on Electrophysiology.** Laboratory training in the proper use of apparatus for stimulation recording and analysis of electrical activity of nerve, muscle, and other tissues. Designed to supplement Physiology 225. Prerequisite: Physiology 225 or equivalent. Spring. 3 units. *Wolbarsht, Anderson, Lieberman, Mandel, Mendell, Moore, Narahashi, and Wachtel*

**393. Integrative and Clinical Neurophysiology.** Aspects of the physiology and pharmacology of the central nervous system in health and in disease: sensory coding; reflex functions; motor control; effects of drugs on the CNS; physiological aspects of memory. Spring. 3 or 4 units. Extra unit available upon consent of instructor. *Somjen or Staff*

**401. Metabolic and Developmental Physiology.** Cell division and control of the cell cycle; population dynamics; physiology of subcellular organelles such as nuclei, mitochondria, lysosomes, and peroxisomes; metabolic regulation. Prerequisite: Biochemistry 247 or equivalent. Fall. 3 units. *Blum, Padilla, or Staff*

**414. Analysis of Physiological Systems.** Several physiological systems analyzed in detail, using a combination of classical mathematical analysis, model-building, and newer analog and digital techniques. Topics covered include diffusion processes, steady state and transient kinetics, and cable equations. Alternate years beginning spring, 1977. 3 units. *Blum, Moore, or Staff*

**416. Biophysics of Excitable Membranes.** Advanced quantitative approach to bioelectric membrane phenomena. Topics include the cable properties of axons, voltage clamping theory and techniques, the ionic mechanisms of excitation, mechanisms of synaptic and neuromuscular transmission, receptor mechanisms, models of membranes and neurons, and the pharmacology of excitable membranes. Prerequisite: Physiology 225 or equivalent; a background in calculus, physics, and physical chemistry is recommended. Alternate years beginning fall, 1978. 3 units. *Moore, Narahashi, Wachtel, or Wolbarsht*

**417. Cellular Endocrinology.** Current concepts of the mechanisms of action of hormones at the cellular level, including hormone-receptor interactions; secondary messenger; regulation of protein synthesis; growth and differentiation; control of salt and water balance; regulation of substrate storage and mobilization; modulation of hormone secretion. Fall. 2 units. *Lebovitz*

**418. Reproductive Biology.** An in-depth survey of male and female reproductive processes including neuroendocrine, pituitary and gonadal control mechanisms, and the physiology of pregnancy and parturition. (Also listed as Anatomy 418.) Spring. 2 units. *Anderson, Blake, Fletcher, Schomberg, or Tyrey*

**419. Topics in Mathematical Physiology.** Microcirculatory models, biological wave propagation, and dimensional analysis and scaling. Prerequisite: consent of instructor. Alternate years beginning spring, 1978. 3 units. *Blum or Moore*

**420. Cellular Immunophysiology.** The interaction of antibodies or plant agglutinins with membrane surfaces and the resulting effects on membrane function and cell physiology. Emphasis on permeability changes in red blood cells and certain nucleated mammalian cells mediated by immune reactions as well as on antibody induced alterations of enzyme activities. (Also listed as Microbiology 420.) Spring. 2 units. *Lauf*

**422. Advanced Seminar in Endocrinology and Reproductive Physiology I.** A weekly seminar based on student and faculty-led discussions of special topics in endocrinology and reproduction. Primarily designed for advanced students with active research interests relating to these areas of mammalian physiology. Prerequisite: consent of instructor. Fall. 2 units. *Anderson, Bell, Everett, Lebovitz, Schomberg, and Tyrey*

**423. Advanced Seminar in Endocrinology and Reproductive Physiology II.** A continuation of Physiology 422 with discussion of topics not covered in the fall term. Prerequisites: Physiology 422 and consent of instructor. Spring. 2 units. *Anderson, Bell, Everett, Lebovitz, Schomberg, and Tyrey*

## Political Science

Professor Barber, *Chairman* (214 Perkins); Associate Professor Johns, *Director of Graduate Studies* (308 Perkins); Professors Braibanti, Cleaveland, Grzybowski, Hall, Hallowell, Holsti, Hough, Kornberg, and Leach; Associate Professors Eldridge, Fish, Hawley, Paletz, Price, Rogowski, Salamon, Spragens, and Valenzuela; Assistant Professors Falcone, Kruzel, McKean, and Mishler; Lecturers O'Barr and Stone

The Department of Political Science offers graduate work leading to the A.M. and Ph.D. degrees. Before being admitted to candidacy for the Ph.D. degree, an applicant is normally expected to have qualified for the A.M. degree.

Instruction is designed to prepare the student for teaching and research, for government service, and for other work related to public affairs. Before undertaking graduate study in political science, a student is ordinarily expected to have completed at least 12 semester hours of course work in political science, including some work in American government. Fields in which instruction is offered currently are American government and politics, comparative government and politics, political theory, international relations, and empirical theory and methodology.

The candidate for the degree of Doctor of Philosophy in political science must take at least twelve courses in the department and demonstrate competence in at least three general fields of the discipline as well as in a fourth general field or in a specialized sub-field or in a field external to the department. The candidate must also demonstrate a reading knowledge of two foreign languages or must demonstrate proficiency in one such foreign language and in the use of statistics.

Further details on the graduate program in political science, the departmental facilities, the staff, and available financial aid may be obtained from the Director of Graduate Studies, Department of Political Science.

## For Seniors and Graduates

**201. Arms Control and Defense Strategy.** Influences on national and international security. Prerequisite: one course in international relations or American foreign policy. 3 units. *Kruzel*

**204. Ethics in Political Life.** Ethical issues arising in the conduct of political vocations and activities. (Also listed as Public Policy Sciences 204.) 3 units. *Spragens*

**206. Politics and the Media.** The relationship between the media of mass communication and the American political process. Open to upperclassmen with consent of instructor. 3 units. *Paletz*

**207. American Constitutional Interpretation.** Development of the constitution of the United States through Supreme Court decisions. Prerequisite: Political Science 127. 3 units. *Fish*

**209. Problems in State Government and Politics.** 3 units. *Leach*

**210. The Politics of Education.** The forces in local, state, and national politics which impinge on educational policy-making and administration. Not open to students who have had Political Science 313. 3 units. (Also listed as Education 210.) *Leach*

**211S. Problems and Issues in Japanese Politics.** The nature of political opposition, citizenship, and the civic culture, decision-making in a "vertical" society, problems as a post-industrial state. 3 units. *McKean*

**212. Japanese Foreign Policy.** The transition from militarism to pacifism in Japan's international posture, emphasis on the postwar American alliance, the questions of rearmament and nuclear weapons, and the domestic constraints on foreign policy-making. 3 units. *McKean*

**215. Comparative Legislative Processes.** Analysis of the structures and functions of legislative institutions and of the behavior of legislative elites in both parliamentary and congressional systems. 3 units. *Mishler*

**216S. Comparative Politics of the Welfare State.** Analysis of the political processes that shape very different solutions of similar social problems in advanced industrial nations. Examination of the development of income-maintenance programs and health care systems, with some discussion of other social policies. (Also listed as Public Policy Sciences 216S.) 3 units. *Stone*

**217S. Economic Theories of Political Behavior.** Analysis of economic theories and other formal techniques applied to problems of voting behavior, legitimacy, and constitutional choice, and to strategies of political conflict and coalition. 3 units. *Rogowski*

**218S-219S. Political Thought in the United States.** Writings of leading political theorists. First semester: founding fathers and their European and Puritan antecedents; the abolitionists and Calhoun. Second semester: progressive period and recurrent themes of contemporary protest and debate. 6 units. *Price*

**220S. Problems in International Politics.** Prerequisite: one course on international relations, foreign policy, or diplomatic history. 3 units. *Holsti*

**221. International Organization.** The functioning of the United Nations system and of regional organizations operating in the political and security fields. 3 units. *Staff*

**222. Empirical Theory.** Critical examination of contemporary, non-normative conceptual frameworks for political inquiry, with emphasis on the qualifications of these frameworks as theories. 3 units. *Staff*

**223. Political Philosophy from Plato to Machiavelli.** Intensive analysis of the political philosophies of Plato and Aristotle, a survey of medieval political thought and an analysis of the significance of Machiavelli. 3 units. *Hallowell*

**224. Modern Political Theory.** An historical survey and philosophical analysis of political theory from the beginning of the seventeenth to the middle of the nineteenth century. Attention is given to the rise of liberalism, the Age of Enlightenment, the romantic and conservative reaction, idealism, and utilitarianism. 3 units. *Hallowell*

**225. Comparative Government and Politics: Western Europe.** Rise of modern political parties; extension of the suffrage; entry of bourgeoisie, peasants, and workers into politics; center-periphery conflicts; emergence of the welfare state and of planned economies; problems of "collectivist" politics. 3 units. *Rogowski*

**226. Theories of International Relations.** Contemporary theories of international relations and foreign policy. Emphasis on the interdependence of theory and empirical research. 3 units. *Eldridge*

**227. International Law.** Elements of international law, particularly as interpreted and applied by the United States; rights and duties of states with respect to recognition, state territory and jurisdiction, nationality, diplomatic and consular relations, treaties, treatment of aliens, pacific settlement of disputes, international regulation of the use of force, and collective responsibility. 3 units. *Grzybowski*

**229. Recent and Contemporary Political Theory.** The rise of positivism and its impact upon modern political thought, the origins of socialism, Marxism and its variants, socialism in the Soviet Union, nationalism, fascism and national socialism, the crisis in modern democracy, Christianity and the social order. (Not open to students who have taken Political Science 132.) 3 units. *Hallowell*

**230. American National Government.** Formation and contemporary operation of the national political system; historical and behavioral approaches. 3 units. *Staff*

**231. American Political Theory.** An analysis of the main currents in American political thought from colonial beginnings to the present day, with emphasis upon the development of liberalism in America. 3 units. *Staff*

**233. Research Methodology.** Measurement, causal analysis, and comparison of different levels of analysis, and other problems in political research. 3 units. *Staff*

**234S. Political Economy of Development: Theories of Change in the Third World.** Alternative approaches to political, economic, and social change in Latin America, Africa, and Asia. (Also listed as History 234S.) 3 units. *Bergquist and Valenzuela*

**235. The Commonwealth.** Analysis of political relationships among the members of the Commonwealth countries, with emphasis on Canada. 3 units. *Staff*

**236. Statistical Analysis.** Introduction to statistics in political research, emphasizing inferential statistics through simple regression and correlation. 3 units. *Staff*

**237S. Problems in American Foreign Policy.** The decision-making process as applied to contemporary foreign policy issues. Prerequisite: Political Science 122 or equivalent. 3 units. *Staff*

**238. Comparative Foreign Policy.** An application of comparative theory to the foreign policy decision-making processes of major, middle range, and developing states. 3 units. *Eldridge*



- 239S. Current Problems of International Law.** Theoretical trends, use of sources for research, role of international law in diplomacy and legal practice. For seniors and graduates only. 3 units. *Grzybowski*
- 241. Public Administrative Organization and Management.** The American administrative process: theory and practice of administrative organization and management. 3 units. *Hall*
- 243. Applications of Administrative and Organizational Theory.** Behavioral analysis of public organizations with emphasis on the impact of organizational structures, individual needs and motivation, and politics on the formulation and implementation of public policy. (Also listed as Public Policy Sciences 224.) 3 units. *Hawley*
- 244. Administrative Law and Process.** The nature and law of the administrative process in the context of American government and politics, with special attention to the powers, procedures, and judicial control of administrative agencies. 3 units. *Hall*
- 245S. Ethics and Policy-making.** (Also listed as Public Policy Sciences 223S.) 3 units. *Price*
- 246. Administration and Public Policy.** The role of administration in the American policy process. 3 units. *Hall*
- 247. Political Participation and Policy Outcomes.** Impact of citizen participation upon governmental decision-making. Theoretical issues and empirical evidence (primarily American, but partly comparative). (Also listed as Public Policy Sciences 247.) *Hough*
- 248. The Politics of the Policy Process.** (Also listed as Public Policy Sciences 219.) 3 units. *Behn and Salamon*
- 249. Comparative Political Analysis and Political Development.** General methodology of comparison of political systems. Institutional, structural, functional, and configurative modes of analysis. Theory of political development. Theoretical problems of induced political change. 3 units. *Braibanti*
- 250. Comparative Government and Politics: Southern Asia.** The political development of India and Pakistan. Contextual determinants of the political systems. Political consequences of partition. National integration, constitutional, and institutional aspects of the political systems. Impact of foreign technical assistance. 3 units. *Braibanti*
- 252. Comparative Political Behavior and Socialization.** Elites and mass publics in a variety of Western and non-Western societies including the United States; models of the political socialization process and their implications for democratic theory. 3 units. *Mishler*
- 253. Comparative Government and the Study of Latin America.** Current literature on major themes of Latin American politics. 3 units. *Valenzuela*
- 257S, 258S. Modern East Asia. Introduction to Problems and Literature.** (Also listed as History 257S, 258S and as Interdisciplinary Course 257S, 258S.) 6 units. *McKean*
- 260. The Tradition of Political Inquiry.** Past and present problems, goals, pre-suppositions, and methods. 3 units. *Spragens*
- 273S. The American South as a "Developing Society."** The concept of modernization as a tool of social and political analysis, and its applicability in explain-

ing the patterns of political and economic evolution in the American South. 3 units. *Salamon*

**274. Political Psychology.** Psychological theories on political attitudes and opinions ranging from those of Fechner, von Helmholtz, Thurstone, and Likert to the more recent work of Festinger, Bem, McGuire, Converse, Lane, and the functionalists. 3 units. *McConahay*

**275. The American Party System.** An intensive examination of selected facets of American national political parties, such as relationships between presidential and congressional politics, the politics of national conventions, recent foreign policy and party alignments, and the controversy over party government. 3 units. *Kornberg*

**277. Comparative Party Politics.** The impact of social and political systems on party structures, functions, ideologies, and leadership recruitment. Emphasis upon research techniques and objectives. 3 units. *Kornberg*

**278. Canadian Political Behavior in the North American Context.** Institutional processes and political behavior in Canadian and American societies. Impact of multi-partyism, federalism, political and cultural particularism, and the elite structure. 3 units. *Kornberg*

**279. The Legislative Process.** An analysis of the structure and functions of Congress with emphasis on the behavior of legislators and resultant public policy. Some considerations will be given to American state and foreign legislatures. 3 units. *Paletz*

**280. Comparative Government and Politics: Sub-Saharan Africa.** Politics and government in selected African states, with particular attention to the problems of decolonization and modernization in the post-independence period. 3 units. *Johns*

**283S. Congressional Policy-making.** Lawmaking and oversight of the bureaucracy by the United States Congress. Committee roles, impact of the executive and other external forces. (Also listed as Public Policy Sciences 283S.) 3 units. *Price*

**285. The Judicial Process.** A study of judicial decision-making in the United States, with emphasis on the process of litigation, the recruitment of judges, the influences and limits on judicial decisions, and their impact within the political system. Prerequisite: Political Science 127 or 207, or equivalent. 3 units. *Fish*

**291. Problems of Urban Government.** 3 units. *Leach*

**293. Federalism.** Theoretical and operational aspects of federal systems of government, focusing on the United States and Canada. 3 units. *Leach*

## For Graduates

**301. Teaching Political Science.** Examination of the art and craft of teaching political science, including philosophy and purposes of education, nature and function of universities, students, teaching content, and course structures and methodologies. 2 units. *Hawley*

**303. Seminar on Selected Topics in Statistics.** Introduction to the assumptions and uses of selected multivariate statistics and research methodologies including least-squares analysis, scaling techniques, factor analysis, causal inference, model-building, and computer simulation. Prerequisite: Political Science 236 or consent of instructor. 3 units. *Mishler*

**306. Seminar in Politics and the Mass Media of Communication.** Prerequisite: Political Science 206 or consent of instructor. 3 units. *Paletz*

**307. Graduate Seminar in American Voting Behavior.** Focus on contemporary and original research in American voting behavior. 3 units. *Staff*

**308. Individual Research in Political Science.** Students will conduct research designed to evaluate hypotheses of their choice. Reports on the research must be presented in adequate professional style. 3 units. *Staff*

**309. Seminar in International Relations.** Critical survey of theories and research in international relations and foreign policy. Emphasis will be placed on the interrelation between theory and research. 3 units. *Holsti*

**310. Seminar in State and Local Government.** Prerequisites: Political Science 209 and 291, or equivalents. 3 units. *Leach*

**312. Seminar in Constitutional Law.** Prerequisite: Political Science 207 or equivalent. 3 units. *Fish*

**313. Education and Public Policy.** (Also listed as Education 313.) Not open to students who have had Political Science 210. 3 units. *Leach and Pittillo*

**321. Seminar in Political Theory.** Prerequisites: 6 units in political science elected from 223, 224, 229, 231, or their equivalents. 3 units. *Hallowell*

**322. Seminar in Selected Topics in Empirical and Formal Theory.** The empirical and formal treatment of concepts such as power, support, rationality, and collective choice. Prerequisite: Political Science 222 or 233, or consent of instructor. 3 units. *Staff*

**323. Seminar in Modern Political Theory.** Prerequisites: two 200-level courses in political theory or consent of instructor. 3 units. *Spragens*

**325. Seminar in Comparative Government and Politics.** 3 units. *Rogowski*

**329. Seminar in International Regional Organization.** Prerequisite: Political Science 221 or equivalent. 3 units. *Staff*

**330. Seminar in Comparative Government and Politics—Southern Asia.** Emphasis on research using documentary materials relating to India, Pakistan, Ceylon, and Malaysia. Prerequisites: Political Science 250 and 251, or equivalents. *Braibanti*

**331. Seminar in American Political Thought.** 3 units. *Leach*

**340. Seminar in American Politics and Institutions.** Survey, analysis, and critique of the literature. 3 units. *Paletz*

**341. Seminar in Public Administration.** Selected topics in administrative and organizational theory and behavior. Prerequisite: Political Science 141 or 243. 3 units. *Staff*

**342. Seminar in American National Government and Politics.** Prerequisite: Political Science 230 or equivalent. 3 units. *Barber*

**343. Seminar in the Policy Process.** Selected topics covering the theory, methodology, and practice of policy formation in American politics. Prerequisite: Political Science 246 or equivalent. 3 units. *Staff*

**344. Workshop on Computer Models of Social Systems.** (Also listed as Computer Science 344 and Economics 344.) 3 units. *Naylor*

**360. Seminar in Government and Politics in the Soviet Union.** Prerequisite: Political Science 165 or consent of instructor. 3 units. *Hough*

**361. Seminar in Foreign Relations of the Soviet Union.** Prerequisite: Political Science 220 or 360, or consent of instructor. 3 units. *Hough*

**376. Seminar in Comparative Political Behavior.** An intensive comparative examination of the impact of selected political institutions on political behavior. 3 units. *Kornberg*

**380. Seminar in African Government and Politics.** Prerequisite: Political Science 280 or equivalent. 3 units. *Johns*

**381. Research Seminar in Latin American Government and Politics.** Prerequisite: Political Science 253 or equivalent. 3 units. *Valenzuela*

**382. Soviet Law and Society.** 2 units. *Grzybowski*

**401. Seminar in the Commonwealth.** 3 units. *Members of the Committee on Commonwealth Studies*

**402. Interdisciplinary Seminar in the History of the Social Sciences.** A survey of the theories, methods, and tools applied to problems in the history of the social sciences. 3 units. *Goodwin, Holley, and Spragens*

### Related Course Work in the School of Law

There may be graduate credit for course work completed in the Duke University School of Law, under regulations referred to in this *Bulletin* under Academic Regulations.

## Psychology

Professor Bevan, *Chairman* (244 Psychology-Sociology); Professor Staddon, *Director of Graduate Studies* (242 Psychology-Sociology); Professors Alexander, Borstelmann, Carson, Diamond, C. Erickson, R. Erickson, Guttman, Jones, Lakin, Lockhead, H. Schiffman, M. Wallach, and Wing; Associate Professors Coie, Costanzo, Hall, and McConahay; Assistant Professors Eckerman, Fischer, Kalat, Kremen, Levy, Norton, Robinson, and Roth; Lecturers Casseday, Crovitz, Gentry, Marsh, Oppenheim, Peele, S. Schiffman, Shows, Somjen, L. Wallach, and Wolbarsht; Visiting Scholar Moulton

The department offers work leading to the Ph.D. degree. The areas of concentration are experimental, biological, cognitive, social, personality, developmental, and clinical psychology. Students in experimental, biological, and cognitive psychology should have a strong undergraduate background in the basic sciences: mathematics, physics, biology, and chemistry.

A brochure is available from the Director of Graduate Studies which describes the program in more detail and gives information on financial assistance, facilities, and current research activity.

### For Seniors and Graduates

**203. Sensation and Perception.** An examination of the classical concepts in sensation and perception and of the resulting psychophysical data for each of the major senses with emphasis on vision and audition. Modern perceptual formulations are discussed through analysis of the empirical evidence in support of each view. 3 units. *Lockhead*



**206. Comparative Psychology.** Eminent comparative psychologists and their work. 3 units. *Kalat*

**210. Cognitive Psychology.** Theoretical approach; stresses interconnections across perception, memory, thinking, language, and use of models. 3 units. *Robinson*

**212. Human Memory.** Literature, classical and modern; data and theories relating to mechanisms of information processing, storage, and retrieval. 3 units. *Bevan*

**213. Adaptive Behavior.** The principles of adaptive behavior in animals, with special emphasis on the effects of reward and punishment. Prerequisite: consent of instructor. 3 units. *Staddon*

**214, 215. Developmental Psychology.** Current research and theory. First semester: comparative and biological approaches to human development. Infancy and social development. Second semester: cognitive development. 6 units. *Eckerman, L. Wallach, and Staff*

**216. Biological Psychology.** The methods of biology (as applied to psychology), especially in neurophysiology, neuroanatomy, and genetics. Topics covered include: the genetics of behavior, the organization of the dorsal thalamus and neocortex, and the limbic system and hypothalamus. Methods covered include: ablation method, method of evoked potential, electrical stimulation of the brain, and classical and physiological genetics. 3 units. *Diamond*

**217. Social Psychology.** Social factors in cognition, models of social interaction, conformity and social influence, and attitude development and change. 3 units. *Jones*

**218. Research Methods in Social Psychology.** Emphasis on the interplay between experimental design and technique. 3 units. *Staff*

**219. Neural Bases of Behavior.** Structure and function of the nervous system as related to problems of sensory-motor processes, learning, and memory. 3 units. *R. Erickson*

**228. Visually Guided Behavior.** Anatomical and physiological maturation of the nervous structures mediating visual behaviors. How the maturation of the visual pathway may contribute to the development of these behaviors. 3 units. *Norton*

**230. Social Behavior of Animals.** Developmental, ecological, and physiological aspects of territorial, sexual, parental, and aggressive behavior. 3 units. *C. Erickson*

**234. Seminar in Personality.** Selected topics of current interest concerning empirical research on personality. Strategies for the definition of research questions and the evaluation of research progress. 3 units. *M. Wallach*

**238. Electroencephalogram and Psychological Function.** A survey of experimental and clinical literature on brain wave correlates of intelligence, personality, behavior disorders, epilepsy, sleep, sensory stimulation, reaction time, and attention. Emphasis on the electrophysiology of conditioning and learning. Lectures, laboratory demonstrations, and clinical case presentations. 3 units. *Marsh*

**245. Personality Theory I.** Representative theories of human functioning, from Freud to contemporary approaches. 3 units. *Staff*

**253. Psychological Approaches to Public Policy Analysis.** (Also listed as Public Policy Sciences 253.) 3 units. *McConahay*

**261. Science, Politics, and Government.** The structure and values of the science

tific community, the mechanism and strategies of government, and their mutual interdependence in American society. (Also listed as Public Policy Sciences 255 and Sociology 261.) 3 units. *Bevan or McKinney*

**271S. Selected Problems.** 3 units. *Staff*

**273-274. Statistical Principles in Experimental Design.** The problems of scientific inference; methods of data analysis and issues in experimental design. 6 units. *Roth*

**276. Neuroanatomical Basis of Sensory Physiology.** Original papers concerned with the neuroanatomical substrates underlying sensory processing in the auditory and visual systems are read and discussed. (Also listed as Anatomy 276.) 3 units. *Hall*

**280. Psychology as a Science.** Epistemology of psychology in its historical evolution from Mach, Newton, and Kant through Darwin, Freud, and Hull; emphasis on practice in current areas of science; roles of research techniques and language, construct usage, hypotheses, and general processes of developing understanding in various current areas. 3 units. *R. Erickson*

**283, 284. The History of Psychology.** First semester: Aristotle to Kant; second semester: development of modern psychology. Prerequisite for 284: Psychology 283 or consent of instructor. 6 units. *Guttman*

**293. Methods in Developmental Psychology.** Methodological and epistemological issues in research in development. Individual and group research projects are an integral part of the course. 3 units. *Staff*

#### **For Graduates**

**305. Psychopathology.** An examination of behavior disorders, with particular emphasis on explanatory concepts and the evidence from research in this field. 3 units. *Staff*

**306. Seminar in Developmental Psychology.** Selected topics in cognitive, emotional and social development. 3 units. *Staff*

**307. Introduction to Methods in Psychotherapy.** Current trends in psychotherapeutic practice and research. Application of principles drawn from theories of personality to individual and group psychotherapy. 3 units. *Carson or Martin Lakin*

**309. Seminar in Learning.** Selected topics in operant conditioning and discrimination learning. 3 units. *Staddon*

**310. Seminar in Perception.** 3 units. *Lockhead*

**314. Seminar in Instrumental Behavior.** 3 units. *Staff*

**316. Seminar in Social Psychology.** 3 units. *Jones*

**317. Seminar in Social Behavior.** 3 units. *Staff*

**319-320. Research Apprenticeship I.** 6 units. *Staff*

**321. Seminar in Psychophysiology of Hearing.** An examination of the relation of anatomy and physiology to psychophysics of the auditory system. Prerequisite: consent of instructor. 3 units. *Casseday*

**325. Seminar in Animal Behavior.** Selected topics in the reproductive behavior of animals. 3 units. *C. Erickson*

**329-330. Pro-Seminar in Psychology.** An intensive examination of original sources in experimental and biological psychology. Ordinarily taken by all students in the natural-science division in their first year of residence. 6 units. *Staff*

**331-332. Research Apprenticeship II.** 6 units. *Staff*

**333, 334. Seminar: Behavioral Studies of the Brain.** Selected topics in the neural bases of behavior. 3 units each semester. *R. Erickson and Norton*

**335-336. Clinical Inquiry I.** This course focuses on the process of understanding intra- and inter-person systems, largely in a practicum context. 6 units. *Staff*

**337. Seminar in Sensory Discrimination.** The neural bases of discrimination in vertebrates and invertebrates is studied by neurophysiological, electrophysiological, and psychophysical techniques. 3 units. *R. Erickson and Wolbarsht*

**340. Group Processes and Sensitivity Training.** 3 units. *Lakin*

**341-342. Clinical Practicum.** 6 units. *Staff*

**343, 344. Clinical Inquiry II.** Intensive experience and supervision in techniques of psychotherapy and behavior modification. 3 units each semester. *Staff*

**347-348. Personality Assessment.** Introduction to the assessment of human personality through the study of personal documents, interview data, objective and projective test material. Laboratory sessions will be concerned with personality assessment of normal human subjects over extended time periods. 6 units. *Alexander or Kremen*

**350. Practicum in Psychological Research.** Ordinarily taken by all students in the natural-science division in their first semester of residence. 3 units. *Staff*

**393. Integrative and Clinical Neurophysiology.** (Also listed as Physiology 393.) 3 units. *Somjen or Staff*

## Public Policy Sciences

Professor Fleishman, *Director* (114 Old Chemistry); Associate Professor Hawley, *Associate Director and Director of Graduate Studies* (109B Old Chemistry); Professors Estes (Medicine), Hough (Political Science), and Lange (Law); Associate Professors Behn, Blaydon, Ginsburg, Grabowski, McConahay, and Price; Assistant Professors Decker, Fischer, Goodwyn, Kuniholm, Lipscomb, Nagin, Salamon, Stack, and Stone; Lecturers Payne and Vaupel

The graduate program in public policy sciences is offered through the Institute of Policy Sciences and Public Affairs. The course of study consists of a series of joint degree programs leading to the degrees of Master of Arts in public policy sciences, and a doctoral or professional degree. Such a program is designed to foster in highly trained professionals the perceptual and analytical skills necessary for sound public decision-making. The Institute does not award independent A.M. or Ph.D. degrees.

With the exception of those individuals already possessing doctoral or professional degrees, therefore, all graduate students in the Institute must pursue a concurrent degree in another department or school at Duke, or at a nearby cooperating institution. Joint degree programs exist or are being developed between the Institute and the Schools of Law, Divinity, Engineering, Medicine, Environmental Management, Forestry, Business Administration, and with several graduate departments, as well as with nearby institutions.

Students usually apply for the joint degree program simultaneously with their

applications to the graduate departments or professional schools, or during their first or second year of advanced study. Candidates are expected to complete an equivalent of at least one full year of work beyond that which their doctoral or professional degree would require.

The joint degree curriculum involves a minimum of ten courses, to be specified by the Institute. Academic work includes a two- to three-course research sequence and a summer internship in one of several policy areas such as law and the administration of justice, communications, health, and education. This policy-research sequence, in which the student works closely with faculty in tutorial or small group situations, stresses the development of analytical skills applicable to the broad range of policy arenas.

Further information concerning specific joint degree programs may be obtained from the Director of Graduate Studies.

### For Seniors and Graduates

**204. Ethics in Political Life.** (Also listed as Political Science 204.) 3 units. *Spragens*

**216S. Comparative Politics of the Welfare State.** (Also listed as Political Science 216S.) 3 units. *Stone*

**217. Microeconomics and Public Policy-making.** Consumption and production theory, welfare economics, theories of collective choice, market structures and regulation, and nonmarket decision-making. 3 units. *Cook, Lipscomb, or Behn*

**219. The Politics of the Policy Process.** The formulation of public policy-making, substantive policies in a variety of contexts from local government to international affairs; the role of legislatures, interest groups, executive branches, and the bureaucracy in defining alternatives and in shaping policy from agenda formulation to implementation. (Also listed as Political Science 248.) 3 units. *Salamon and Stone*

**221. Analytical Methods I: Decision Analysis for Public Policy-makers.** Methods for structuring decision dilemmas and decomposing complex problems, assessing the probabilities of uncertain consequences of alternative decisions, appraising the decision maker's preferences for these consequences and for reexamining the decision. (Not open to students who have taken Public Policy Studies 55.) 3 units. *Blaydon, Fischer, or Behn*

**222. Analytical Methods II: Data Analysis for Public Policy-makers.** Sampling theory, Bayesian statistics, and regression analysis. Examples from problems in health care, transportation, crime, urban affairs, and politics. (Not open to students who have taken Public Policy Studies 112.) 3 units. *Behn, Fischer, or Vaupel*

**223S. Ethics and Policy-making.** Normative concepts in politics—liberty, justice, the public interest. Historical and philosophical roots; relations to one another and to American political tradition; and implications for domestic policy problems. (Also listed as Political Science 245S.) 3 units. *Price*

**224. Applications of Administrative and Organizational Theory.** (Also listed as Political Science 243.) 3 units. *Hawley*

**231. Analytical Methods III: Evaluation of Public Programs and Policies.** Theoretical treatment of cost-benefit analysis; discussion of several prospective and retrospective evaluations of public programs and policies. Examples from law enforcement, health, income maintenance and other policy areas. Prerequisites: Public Policy Studies 55 or Public Policy Sciences 221; Public Policy Studies 112 or



Public Policy Sciences 222; and Public Policy Studies 110, Public Policy Sciences 217, or Economics 149. 3 units. *Cook and Fischer*

**232. Analytical Methods IV: Regression and Simulation Techniques for Policy Analysis.** Topics: Statistical and simulation techniques appropriate for evaluation and projection in cases where the analyst has non-experimental data; positive and normative aspects of public regulation of the private sector. 3 units. *Staff*

**233. Analytic Approaches to Bargaining, Cooperation, and Competition.** Application of principles of game theory, economics, and psychology to labor-management negotiation, plea bargaining, public interest group formation, corporate collusion, business mergers, and arms limitations. 3 units. *Blaydon and Fischer*

**236S. Public Financial Management.** State and local governments. Budgetary requirements and fund raising. 3 units. *Blaydon*

**246. Population Policy.** (Also listed as Sociology 246.) 3 units. *Back*

**247. Political Participation and Policy Outcomes.** (Also listed as Political Science 247.) 3 units. *Hough*

**252S. National Security Policy.** Application of decision analysis and normative and organizational theory and historical systems, to major strategic decisions, and selected foreign policy issues. 3 units. *Fischer and Kuniholm*

**253. Psychological Approaches to Public Policy.** Contribution of psychological analysis to an understanding of social issues such as poverty, drug abuse, crime, crowding, and race relations, the ways problems are recognized, and why different policy alternatives are selected (e.g., those that "blame the victim"). (Also listed as Psychology 253.) 3 units. *McConahay*

**254. Transportation Planning and Policy Analysis.** (Also listed as Civil Engineering 216.) Prerequisite or corequisite: Civil Engineering 116 or consent of instructor. 3 units. *Behn*

**255. Science, Politics, and Government.** An examination of the structure and values of the scientific community; the mechanisms and strategies of government; and their mutual interdependence in American society. (Also listed as Psychology 261 and Sociology 261.) 3 units. *Bevan and McKinney*

**256. The Economics of Health Care.** An examination of the health care industry and government policies. Topics include national health insurance; the relationship between insurance, supply constraints, and inflation; the supply and distribution of health manpower; hospital cost containment policy; and approaches to the "optimal" allocation of health care viewed as a social good. Prerequisite: Economics 149, or equivalent, or consent of instructor. 3 units. *Lipscomb*

**260S. Public Policy Research Seminar: The Administration of Justice.** Examination of public policy issues concerning the administration of justice. 3 units. *Staff*

**261S. Research Seminar: Health Policy.** Determinants and impacts of public policies designed to improve the equity and efficiency of health services. The supply and distribution of services; the cost of services and alternative modes of financing; the quality of services and alternative mechanisms of quality control. Applied research paper. 3 units. *Lipscomb and Stone*

**262S. Research Seminar in Communications.** Examination of public policy issues in the communications field. 3 units. *Lange*

**263S. Public Policy Research Seminar: Urban and Regional Development Policy.** Dynamics of urban and regional development analyzing alternative policy instruments for coping with the social, environmental, and economic effects. Housing, land use, transportation, taxation, environmental protection, and related urban development problems and policies. Prerequisite: Political Science 176, Political Science 109, Economics 234, or consent of instructor. 3 units. *Salamon*

**264S. Public Policy Research Seminar: Topics in Public Policy I.** Selected topics. 3 units. *Staff*

**270S. Humanistic Perspectives on Public Policy.** Modes of inquiry into aspects of social life important to policy-makers but beyond the normal reach of social science. Reading from James Agee, Robert Coles, Eudora Welty, James Baldwin, George Eliot, and others. Prerequisite: consent of instructor. 3 units. *Payne and Coles*

**271. The Uses of History in Public Policy: I.** Introduction to historical analysis as a technique for formulating and evaluating public policy. (Also listed as History 203.) 3 units. *Staff*

**272. Poverty in the United States: An Historical Perspective.** Social, political, and cultural origins and contemporary policy alternatives. (Also listed as History 272.) 3 units. *Decker*

**273. The Uses of History in Public Policy II.** Introduction to historical analysis as a technique for formulating and evaluating public policy. Emphasis on public policy decisions abroad since World War II, including the structuring of selected contemporary problems in light of their historical contexts. 3 units. *Kuniholm*

**274. Sanity in Society: Mental Health Policy in the United States.** Examines the relationships between cultural views of health and illness among diverse ethnic groups and social classes and national policies to deal with mental health problems. 3 units. *Stack*

**275. Class, Ethnicity, and Social Policy.** The uses of anthropological modes of analysis for understanding social issues and public policy, with a focus on class, work, ethnicity, sex roles, and the family. (Also listed as Anthropology 277.) 3 units. *Stack*

**283S. Congressional Policy-making.** (Also listed as Political Science 283S.) 3 units. *Price*

**284S. Research Seminar in Communications Policy.** Guided research in and analysis of selected areas of communications policy, especially those dealing with regulation of the media and other forms of public expression. 3 units. *Lange*

### **For Graduates**

**301. Public Policy Workshops.** Individual and group work providing experience in applying the knowledge, theory, and skills being taught in one or more of the core courses in public policy concurrently being taken. Open only to graduate students in public policy. 3 units. *Behn*

**302. Public Policy Workshop.** Same as 301 with applications to the subject matter of spring semester courses. 3 units. *Behn*

**340-390. Public Policy Research Seminars.** Students pursuing a Master of Arts degree in public policy sciences are expected to take a series of two or three sequential courses which examine issues in specialized public policy areas, such as

law and the administration of justice, communications, health, urban and regional land use, and education. The series usually begins with a 260-level course, continues with courses from this series, and includes a thesis seminar and a summer internship. 12 units. *Staff*

**391. Multinational Corporations Seminar.** The nature and consequences of multinational corporations. The international economic environment in which multinational corporations operate. The problems of managing a multinational corporation. Public policy toward multinational corporations. (Also listed as Business Administration 391.2.) 3 units. *Vaupel*

## Religion

Professor Poteat, *Chairman* (117B Gray); Professor M. Smith, *Director of Graduate Studies* (209A Divinity School); Professors Baker, Beach, Bradley, Cushman, Davies, Henry, Herzog, Lacy, Langford, Lincoln, Long, Murphy, Osborn, Price, H. Smith, Steinmetz, Wintermute, and Young; Associate Professors Bailey, Charlesworth, Corless, Kort, Lawrence, Meyers, Partin, Raitt, and Robinson; Assistant Professor Gregg

The Department of Religion offers graduate work leading to the A.M. and Ph.D. degrees. Students may major in one of three fields: (1) Biblical studies; (2) historical studies; and (3) systematic and contemporary studies. They will be expected to take such courses in one or both of the other fields which will contribute to an adequate understanding of their chosen fields of specialization.

In addition to course work in these major fields, students will take such other courses in cognate fields as will contribute to the enrichment of their major studies. This minor requirement may be fulfilled either by work in a cognate department, such as classical studies, history, political science, or sociology, or by work in a cognate field within the Department of Religion other than the field of major concentration.

The program of doctoral studies presumes a foundation in the academic study of religion. Students applying for graduate work in religion directly from an undergraduate program should have had a strong undergraduate major in religion, and will be accepted for the Ph.D. program only upon the satisfactory completion of the A.M. degree with the department.

### FIELD I. BIBLICAL STUDIES

**207. Second Hebrew.** Historical Hebrew grammar with reading and exegesis of Old Testament prose: Pentateuch and historical books in alternate years. First semester. 3 units. *Wintermute*

**208. Second Hebrew.** Historical Hebrew grammar and rapid reading of prose and poetry. Second semester. 3 units. *Murphy*

**209. Old Testament Theology.** Studies of the Old Testament in regard to theological themes and content. 3 units. *Murphy*

**220. Third Hebrew.** An interpretive study of late Hebrew prose, with readings from Chronicles, Ecclesiastes, and the Mishnah. 3 units. *Davies or Meyers*

**221. Readings in Hebrew Biblical Commentaries.** Selected Hebrew texts in Midrash Aggadah and other Hebrew commentaries reflecting major trends of classical Jewish exegesis. 3 units. *Bland*

**223A. Exegesis of the Hebrew Old Testament: Amos and Hosea.** Interpretation based upon Hebrew exegesis, stress upon hermeneutic methods. 3 units. *Bailey*

- 223B. Exegesis of the Hebrew Old Testament: Job. 3 units. *Murphy*
- 223C. Exegesis of the Hebrew Old Testament: Exodus. 3 units. *Bailey*
- 223D. Exegesis of the Hebrew Old Testament: Song of Songs. 3 units. *Murphy*
225. **Living Issues in New Testament Theology.** Critical examination of major problems and issues in New Testament interpretation and theology. 3 units. *M. Smith*
- 226A. Exegesis of the Greek New Testament I (Mark and Matthew). 3 units. *Price or Smith*
- 226B. Exegesis of the Greek New Testament I (Romans). 3 units. *Price*
- 226D. Exegesis of the Greek New Testament I (I and II Corinthians). 3 units. *Price and M. Smith*
- 226E. **The Gospel and Epistles of John.** Exegesis of the Johannine literature in Greek. 3 units. *M. Smith*
- 227A. Exegesis of the Greek New Testament II (Luke-Acts). 3 units. *Young*
- 227B. Exegesis of the Greek and New Testament II (Galatians). 3 units. *M. Smith*
- 227C. Exegesis of the Greek New Testament II (The Pastoral Epistles). 3 units. *Young*
237. **History of the Ancient Near East.** Emphasis upon the religions, literature, and art of Mesopotamia. 3 units. *Bailey*
239. **Introduction to Middle Egyptian.** Grammar and readings in hieroglyphic texts relating to the Old Testament. 3 units. *Wintermute*
242. **Life After Death in Semitic Thought.** Consideration of the various ideas from the early second millennium through the Intertestamental Period. Exegesis of selected Old Testament passages. Evaluation of recent research. Knowledge of Hebrew helpful but not required. 3 units. *Bailey*
244. **The Archeology of Palestine in Hellenistic-Roman Times.** The study of material and epigraphic remains as they relate to Judaism in Hellenistic-Roman times, with special emphasis on Jewish art. Prerequisite: reading knowledge of a Biblical language. 3 units. *Meyers*
258. **Coptic.** Introduction to the Sahidic dialect with selected readings from Christian and Gnostic texts. Prerequisite: at least one year of Greek. 3 units. *Wintermute*
302. **Studies in the Intertestamental Literature.** Selected documents of the Apocrypha and Pseudepigrapha examined exegetically and theologically in their relation to post-exilic Judaism. Prerequisite: consent of instructor. 3 units. *Charlesworth*
304. **Aramaic.** A study of the Aramaic portions of the Old Testament and selected passages from the Targums, Midrashes, and Talmuds. 3 units. *Meyers or Murphy*
- 304A. **Targumic Aramaic.** An introduction to the language and literature of the Aramaic translations of the Old Testament. 3 units. *Meyers*
306. **Language and Literature of the Dead Sea Scrolls.** A study in interpretation. Prerequisite: a knowledge of Hebrew. 3 units. *Charlesworth*



**307. Syriac.** A study of the script and grammar, with readings from the Syriac New Testament and other early Christian documents. Prerequisite: some knowledge of Hebrew and Aramaic. 3 units. *Charlesworth*

**311. Pharisaic Judaism in the First Century.** A reading course in first-century Pharisaic Judaism. 3 units. *Davies*

**312. Pauline Theology.** Studies in aspects of Paulinism in the light of recent scholarship. 3 units. *Davies*

**314. Judaism and Christianity in the New Testament.** Their interaction. 3 units. *Davies*

**319. The Gospel According to St. Matthew in Recent Research.** 3 units. *Davies*

**323A. Comparative Semitic I.** An introduction to the morphology and syntax of classical Arabic and the Semitic languages of Mesopotamia, together with a consideration of their relationship to Hebrew. 3 units. *Wintermute*

**323B. Comparative Semitic II.** An introduction to the morphology and syntax of classical Ethiopic and the Semitic languages of Palestine-Syria, together with a consideration of their relationship to Hebrew. 3 units. *Wintermute*

**340-341. Seminar in the New Testament.** Research and discussion on a selected problem in the Biblical field. 3 units each semester. *Price, M. Smith, and Young*

**345. The Epistle to the Hebrews in Recent Research.** Intensive attention to the text and to secondary sources. 3 units. *Davies*

**350-351. Old Testament Seminar.** Research and discussion on selected problems in the Old Testament and related fields. 3 units each semester. *Murphy*

**353. Seminar on Text Criticism.** Emphasis upon transmission, versions, apparatus, and method. Prerequisite: reading knowledge of Hebrew and Greek. 3 units. *Bailey*

**373-374. Elementary Akkadian.** Study of the elements of Akkadian grammar. Reading of neo-Assyrian texts shedding light on the Old Testament. Prerequisite: Biblical Hebrew. 6 units. *Bailey*

**375-376. Elementary Ugaritic.** Study of the elements of Ugaritic. Prerequisite: Biblical Hebrew. 6 units. *Bailey*

**401. Colloquium in Biblical Studies.** A colloquium in which all graduate faculty and students in the Biblical division participate. Research papers in the Biblical field are read and discussed.

## FIELD II. HISTORICAL STUDIES

**206. Christian Mysticism in the Middle Ages.** Source studies in historical perspectives of such late medieval mystics as Bernard of Clairvaux, the Victorines, Ramon Lull, Meister Eckhart, Richard Rolle, Catherine of Siena, and Nicholas of Cusa. 3 units. *Raitt*

**217. Islam in India.** History and thought of major Indian Muslims from Biruni to Wali-Ullah, with special attention to the role of Sufism. An introduction to selected Muslim scholars and saints who contributed to the interaction between Islam and Hinduism in Northern India during the second millennium A.D. 3 units. *Lawrence*

**218. Religion in Japan.** A survey of religion in Japan, with special emphasis on indigenization and attempts at synthesis. An approach to the meaning of the words *religious* and *secular* in the Japanese situation. 3 units. *Corless*

**219. Augustine.** The religion of the Bishop of Hippo in the late antiquity. 3 units. *Gregg*

**236. Luther and the Reformation in Germany.** The theology of Martin Luther in the context of competing visions of reform. 3 units. *Steinmetz*

**238. Jewish Responses to Christianity.** Apologetic and polemical themes in rabbinic, medieval, and contemporary writings. 3 units. *Bland*

**241. Problems in Reformation Theology.** 3 units. *Steinmetz*

**246. Problems in Historical Theology.** Prerequisite: consent of instructor. 3 units. *Raitt*

**247. Readings in Latin Theological Literature.** Critical translation and study of important theological texts in Latin from various periods of the history of the Church. 3 units. *Steinmetz or Raitt*

**251. The Counter-Reformation and the Development of Catholic Dogma.** Issues in Roman Catholic theology from the Reformation to the Second Vatican Council. 3 units. *Raitt*

**260. Seminar: Wesley Studies.** The lives and thoughts of John and Charles Wesley and their colleagues in relation to English culture and religion in the eighteenth century. 3 units. *Baker*

**280. The History of Religions.** A study of the methodology of the history of religions, the nature of religious experience, and specific categories of religious phenomena. 3 units. *Partin*

**282. Myth and Ritual.** Historical and phenomenological study of myth and ritual in their interrelationships in the history of religions, with particular attention to religious pilgrimage. 3 units. *Partin*

**284. The Religion and History of Islam.** Origins and development of the Islamic community and tradition, with particular attention to the religious element. 3 units. *Partin*

**285. The Vedic Tradition: Compilation and Interpretation.** Indian canonical writings, with emphasis on the literary stages and relation of the writings to later philosophical and religious movements. 3 units. *Lawrence*

**286. Religious Trends in the Indian Subcontinent.** Leaders and movements among the religions of the the subcontinent from the coming of the Europeans to Independence. 3 units. *Bradley*

**287. The Scriptures of Asia.** Translations of basic texts from the religious traditions of India, China, and Japan. 3 units. *Bradley*

**288. Buddhist Thought and Practice.** A historical introduction to Buddhist thought and practice, with special attention to their interrelationship in the living religion. 3 units. *Corless*

**296. Religion on the American Frontier.** A study of the spread of evangelical Christianity as a theological and cultural phenomenon of the American West. 3 units. *Henry*

**308. Greek Patristic Texts.** Critical translation and study of selected Greek texts illustrative of significant aspects of patristic theology and history from the second through the fifth century A.D. 3 units. *Young*

**313. The Apostolic Fathers.** A study of the religious thought in the writings of the Apostolic Fathers. 3 units. *Young*

**315-316. Seminar: History of Religions.** Selected problems in the field. 3 units.

**317. Seminar in the Greek Apologists.** A study of the apologetic writings of the Greek Fathers in relation to the challenges of their contemporary world. Special attention will be given to leading protagonists of late Graeco-Roman culture, such as Celsus, Porphyry, and Julian. 3 units. *Young*

**318. Seminar in the Greek Fathers.** A study of selected topics from the Greek Fathers. 3 units. *Young*

**324. Readings in the History of Religion.** An examination of the theories, methods, and purposes of the study of non-Western religions within the Western tradition. 3 units. *Long*

**334. Theology and Reform in the Later Middle Ages.** The life and thought of the medieval Church from the twelfth century through the fifteenth. Popular and academic theologians from Pierre Abelard to Gabriel Biel. 3 units. *Steinmetz*

**335. The English Church in the Eighteenth Century.** Studies of Christianity in England from the Act of Toleration, 1689, to the death of John Wesley, 1791. 3 units. *Baker*

**338. Calvin and the Reformed Tradition.** The theological development of John Calvin. A comprehensive examination of his mature position with constant reference to the theology of other reformers. 3 units. *Raitt or Steinmetz*

**339. The Radical Reformation.** Protestant movements of dissent in the sixteenth century. Special attention will be devoted to Muntzer, Carlstadt, Hubmaier, Schwenckfeld, Denck, Marpeck, Socinus, and Menno Simons. 3 units. *Steinmetz*

**344. Zwingli and the Origins of Reformed Theology.** Source studies in the early Reformed tradition. 3 units. *Steinmetz*

**384. Religious Dissent in American Culture.** History and significance of dissent in the theology and culture of America. 3 units. *Henry*

**385. Religion in American Literature.** A critical study of the meaning and value of religious motifs reflected in American literature. 3 units. *Henry*

**392. Historical Forms of Protestant Ethics.** A survey of major types of Protestant ethical theory from Luther through contemporary figures. 3 units. *Beach*

**395. Christian Thought in Colonial America.** Exposition of the main currents in Protestant theology. 3 units. *Henry*

**396. Liberal Traditions in American Theology.** A study of the main types of modern religious thought, beginning with the theology of the Enlightenment. 3 units. *Henry*

### FIELD III. SYSTEMATIC AND CONTEMPORARY STUDIES

**210. Contemporary British Theology.** A study of twentieth-century British theology. Attention will be given to the Anglican, Free Church, and Scottish traditions. 3 units. *Langford*

**211. Authority in Theology.** The idea and function of authority in theology. 3 units. *Langford*

**214. The Christian Doctrine of Salvation.** A systematic exposition and restatement of the historic faith of the Church in relation to representative secular alternatives of ancient and modern times. 3 units. *Cushman*

**230. The Meaning of Religious Language.** An analysis of the credentials of some typical claims of theism in the light of theories of meaning in recent thought. (Also listed as Philosophy 230.) 3 units. *Poteat*

**231. Seminar in Religion and Contemporary Thought.** Analytical reading and discussion of such critical cultural analysis as is found in the works of Polanyi, Arndt, Trilling, and others, with appraisal of the relevance of theological inquiry. 3 units. *Poteat*

**232. Methods in Religion and Literature.** An examination of various scholarly methods for identifying and addressing issues and problems in religion and literature. 3 units. *Kort*

**233. Modern Narratives and Religious Meanings.** A study of kinds of religious meaning or significance in representative American, British, and Continental fiction of the first half of the twentieth century. 3 units. *Kort*

**245. Ethics in World Religions.** Moral foundations, assumptions and applications in such major faiths as Hinduism, Buddhism, Confucianism, and Islam, in the light of Christian ethical perspectives. 3 units. *Lacy*

**248. The Theology of Karl Barth.** A historical and critical study of the theology of Karl Barth. Prerequisite: consent of instructor. 3 units. *Osborn*

**262. Marxist Ideology and Christian Faith.** Comparative examination of Communist and Christian doctrines, such as man, society, sin, history, and eschatology, together with an introduction to the contemporary dialogue. 3 units. *Lacy*

**264. The Sociology of the Black Church.** An effort to identify, define, and interpret the Black Church. 3 units. *Lincoln*

**265. The Religions of the West Africa Diaspora.** Religious development of Africans displaced to the Western Hemisphere by slavery. 3 units. *Lincoln*

**272. Topics in Comparative Theology.** Theological categories in Christian and Eastern Religious traditions, focusing on such topics as man, God, salvation, eschatology. 3 units. *Lawrence and Osborn*

**281. Phenomenology and Religion.** Scheler, E. Strauss, Merleau-Ponty, Ricoeur, Binswanger, or others; their bearing upon religious knowledge and practice. Prerequisite: consent of instructor. 3 units. *Poteat*

**292. Christian Ethics and International Relations.** An examination of Christian attitudes toward such issues as war and peace, the rule of law, foreign aid, and human rights; and the Church's contribution to international policies and institutions. 3 units. *Lacy*

**300. Systematic Theology.** Method and structure of systematic theology, the doctrine of God, theological anthropology, and Christology. 3 units. *Cushman, Herzog, or Langford*

**303. The New Hermeneutic and the Idea of History.** A critical examination of key thinkers in present-day European systematic theology: Fuchs, Ebeling, Molt-



mann, Ott, and Pannenberg, in the light of Ernst Bloch's philosophy. 3 units. *Herzog*

**320. Theology, Power, and Justice.** Critical examination of a major theme of modern Protestant thought in Hegel, Marx, Schleiermacher, and Tillich. 3 units. *Herzog*

**322. Nineteenth-Century European Theology.** Protestant theology from Kant to Herrmann. 3 units. *Herzog*

**325. Philosophical Theology I.** Theology, as the knowledge of God, considered in dialogue with selected pagan and Christian philosophers from Plato to Kant. 3 units. *Cushman*

**326. Philosophical Theology II.** Continuation of Philosophical Theology I. 3 units. *Cushman*

**328. Twentieth-Century European Theology.** Critical examination of the thought of selected Protestant theologians from 1900 to 1950. 3 units. *Herzog*

**352. Seminar in Christian Theology.** Research and discussion of a selected problem in the systematic field. 3 units. *Staff*

**360. Special Problems in Religion and Culture.** Intensive investigation of the relations of religion and modernity, using seminal contemporary texts. Topics announced each semester. Prerequisite: consent of instructor. 3 units. *Poteat*

**361. Language and Biblical Criticism.** An attempt to explore the bearing of recent investigators into the nature of language upon problems in the study of Biblical texts. Prerequisite: consent of both instructors. 3 units. *Poteat and Charlesworth*

**370. Seminar in Religion and Literature.** Analysis and discussion of theories and of individual research projects. 3 units. *Kort*

**377. Contemporary American Dramatic Arts and Evolving Theological Forms.** An examination of creed and ritual implicit and explicit in contemporary American theater, film, and television. 3 units. *Henry*

**380. Existentialist Thought.** An exploration of the interests and motifs of Existentialism in relation to modern philosophy and theology through an analysis of representative writings of Kierkegaard, Heidegger, Berdyaev, Marcel, and Sartre. 3 units. *Poteat*

**383. Moral Theology in the Twentieth Century.** Critical and comparative examination of ethical theory as exhibited in the work of selected contemporary theologians. 3 units. *H. Smith*

**386. Christianity in Dialogue with Other Faiths.** Contemporary currents of Christian thought as they affect resurgent non-Christian faiths, new formulations of a theology of mission, and ecumenical conversations. 3 units. *Lacy*

**388. Ethics and Medicine.** A critical study of selected aspects of modern biomedical technology, with special reference to the ethical assumptions informing their development and practice. 3 units. *H. Smith*

**389. Christian Ethics and Contemporary Culture.** A study of the interaction between Christian thought and current social theory. 3 units. *Beach*

**390. Current Problems in Christian Ethical Theory.** A critical study of dominant issues in Christian ethics. Contextualism, the technological revolution, and the ecological crisis. 3 units. *Beach*

**394. Christianity and the State.** The relation of the Christian theory of the state to political problems, with special consideration of the religious assumptions underlying democratic theory and practice and of the relationship of church to state. 3 units. *Beach*

**397. Contemporary American Theology.** A critical appraisal of major tendencies. 3 units. *Henry*

**398. Colloquium on the College and University Teaching of Religion.** A consideration of the curricular content and method in the teaching of religion courses. *M. Smith and Others*

## Romance Languages

Professor Tetel, *Chairman* (205 Languages); Associate Professor Vincent, *Director of Graduate Studies* (214 Languages); Professors Cordle, Fein, Fowlie, Niess, Predmore, and Wardropper; Associate Professors Garci-Gómez, Hull, and Stewart; Assistant Professors Caserta and Melzer

The Department of Romance Languages offers graduate work leading to the A.M., M.A.T., and Ph.D. degrees in French and Spanish. Requirements for the A.M. may be completed by submission of a thesis or by passing a comprehensive examination in the major field. It is hoped that candidates for the A.M. and Ph.D. degree will take related work in a second Romance language; however, related work may be taken in any one or two of a number of other subject areas.

In order to undertake graduate study in Romance languages, the entering student should have credit for at least 18 semester hours (or equivalent) above the intermediate level in the major language.

### FRENCH

#### For Seniors and Graduates

**210. The Structure of French.** Modern French phonology, morphology, and syntax. Readings in current linguistic theory. 3 units. *Hull*

**213. French Literature of the Seventeenth Century.** The Baroque and the Classical: form and meaning in the plays of Corneille, Racine, and Molière. Readings in baroque and précieux poetry. 3 units. *Melzer*

**214. The "Moralistes" of the Seventeenth Century.** Rise of modernity. Form and meaning in the works of Descartes, Pascal, La Rochefoucauld, La Fontaine, La Bruyère, Fénelon, and Mme de Sévigné. 3 units. *Melzer*

**217. French Symbolism.** The poetry and theories of Baudelaire, Mallarmé, and Rimbaud. Decadence: Lautréamont, and Laforgue. 3 units. *Fowlie*

**219. Old French Literature.** An introduction to the reading of Old French literary texts. 3 units. *Vincent*

**220. French Pre-Romantic and Romantic Poetry.** Chénier, Vigny, Lamartine, Musset, Hugo, and Nerval. 3 units. *Niess*

**221, 222. The Nineteenth-Century French Novel.** First semester: Romanticism and Romantic Realism, studies especially in the works of Chateaubriand, Stendhal, and Balzac. Second semester: Realism and Naturalism, with special emphasis on Flaubert and Zola. 6 units. *Niess*

**224. History of the French Language.** The evolution of French from Latin to its present form; internal developments and external influences. 3 units. *Hull*

**225. French Prose of the Sixteenth Century.** Rabelais, Marguerite de Navarre, Montaigne, and others. 3 units. *Tetel*

**226. French Poetry of the Sixteenth Century.** A critical appraisal of Villon, Marot, the Ecole Lyonnaise, the Pléiade, and the Baroque poets. 3 units. *Tetel*

**228. French Poetry of the Twentieth Century.** In the wake of symbolism; Valéry and Claudel; poetry as ritual, Péguy; Appollinaire and surrealist poetry; the contemporary movement, Michaux, Char, Saint-John Perse. 3 units. *Fowlie*

**223. Contemporary French Theater.** A study of dramatic theory; the art of the leading directors; and the major texts of Claudel, Giraudoux, Anouilh, Sartre, Beckett, Ionesco, and Genet. 3 units. *Fowlie*

**234. Proust.** A study of *A la recherche du temps perdu*. The thematic structure and the aesthetics of the work. 3 units. *Fowlie*

**241, 242. French Literature of the Eighteenth Century.** First semester: the literature of the Enlightenment, including Montesquieu, Voltaire, Diderot, Rousseau, and the *Encyclopédie*. Second semester: the development of literary forms, with emphasis on the theater and the novel. 6 units. *Stewart*

**245, 246. French Literature of the Twentieth Century.** First semester: to 1935, emphasis on Gide, Mauriac, and Malraux. Second semester: after 1935, emphasis on Sartre, Camus, and the *nouveau roman*. 6 units. *Cordle*

#### For Graduates

**311, 312. French Seminar.** Each semester one of the following topics will be selected for intensive treatment: studies in sixteenth-century literature, studies in eighteenth-century literature, studies in nineteenth-century literature, studies in seventeenth-century literature, studies in contemporary literature, studies in medieval literature. 3 units each semester. *Cordle, Fowlie, Niess, Stewart, Tetel, and Vincent*

— **Graduate Reading Course.** An intensive course in French to develop rapidly the ability to read French in several fields. Graduate students only. No credit.

### ITALIAN

#### For Seniors and Graduates

**283. Italian Novel of the Novecento.** Representative novelists from Svevo to the most recent writers. 3 units. *Caserta*

**284. Dante.** *La Vita Nuova* and a close reading of the *Inferno*. Conducted in English. 3 units. *Fowlie*

**285. Dante.** The *Purgatorio* and the *Paradiso* in the light of Dante's cultural world. Special attention will be given to the poetic significance of the *Commedia*. Prerequisite: Italian 284 or equivalent. 3 units. *Caserta*

**288. The Renaissance.** Petrarch, Boccaccio, and Ariosto. 3 units. *Tetel*

### SPANISH

#### For Seniors and Graduates

**251. The Origins of Spanish Prose Fiction.** A critical study based on close readings and discussion of selected examples of the principal genres of the ro-

mance and the novel: the *Amadís de Gaula*, Diego de San Pedro's *La cárcel de amor*, the *Abencerraje*, the *Lazarillo*, Montemayor's *Diana*. 3 units. *Wardropper*

**252. Spanish Lyric Poetry Before 1700.** A critical study, based on close reading and discussion, of selected poems of the Middle Ages, Renaissance, and Baroque. Special emphasis on the *Razón de amor*, *la poesía de tipo tradicional*, and Santilana; on Garcilaso, San Juan de la Cruz, Fray Luis de León, and Herrera; on Góngora and Quevedo. 3 units. *Wardropper*

**253. The Origins of the Spanish Theater.** A study of the evolution of the Spanish theater from *Auto de los Reyes Magos* (twelfth century) through the end of the sixteenth century. The idea of the theater as dramatic poetry will be stressed; close reading of texts by Gómez Manrique, Encina, Gil Vicente, Torres Naharro, Lope de Rueda, Juan de la Cueva. 3 units. *Wardropper*

**255, 256. Modern and Contemporary Spanish American Literature.** First semester: poetry from *Modernismo* to the present. Second semester: twentieth-century fiction. 3 units. *Fein*

**257. History of the Spanish Language.** Formation and development of Spanish: internal forces and external contributions. 3 units. *Garci-Gómez*

**258. Medieval Literature.** An introduction to selected authors and works. 3 units. *Garci-Gómez*

**259. Spanish Phonetics.** A phonemic approach to the study of Spanish sounds. Remedial pronunciation drills with special emphasis on rhythm and intonation. Readings in current studies of phonology. 3 units. *Predmore*

**260. Origins and Development of Spanish Romanticism.** Representative authors, including Espronceda, Rivas, Zorrilla, Bécquer, and Rosalía de Castro, with a stress on drama and poetry. 3 units. *Staff*

**261. Nineteenth-Century Novel.** A study of literary trends in the last half of the nineteenth century. Readings will be selected from the novels of Valera, Pereda, Galdós, Pardo Bazán, Blasco Ibáñez, and their contemporaries. 3 units. *Staff*

**262. Galdós.** Works selected from the *Novelas contemporáneas*, the *Episodios nacionales*, and his drama. 3 units. *Staff*

**265. Cervantes.** The life and works of Cervantes, with special emphasis on his *Quijote*. 3 units. *Predmore or Wardropper*

**266. Drama of the Golden Age.** Study of the chief Spanish dramatists of the seventeenth century with readings of representative plays of this period. 3 units. *Wardropper*

**275, 276. Contemporary Spanish Literature.** First semester: the essay and lyric poetry. A study of the revision of national values and literary expression in the twentieth century, with particular reference to the crisis of 1898 and to the enrichment of the Spanish tradition through extra-peninsular influences. Second semester: a study of tradition and innovation in the twentieth-century Spanish novel with emphasis on the novels of Unamuno, Baroja, Valle Inclán, and Pérez de Ayala. 6 units. *Predmore*

## For Graduates

**321, 322. Hispanic Seminar.** Each semester one of the following topics will be selected for intensive treatment: the Spanish language in America, studies in



medieval literature, studies in the literature of the Golden Age, studies in Latin American literature, studies in the Spanish Renaissance and Baroque, studies in Spanish poetry, studies in nineteenth-century Spanish literature, and studies in twentieth-century literature. 6 units. *Fein, Garci-Gómez, Predmore, and Wardropper*

## ROMANCE LANGUAGES

**218. The Teaching of Romance Languages.** Evaluation of objectives and methods; practical problems of language teaching at the elementary, secondary, and college levels; analysis of textbooks, texts, and audiovisual aids; applied linguistics. 3 units. *Hull*

## Slavic Languages and Literatures

Professor Krynski, *Chairman* (314 Languages); Associate Professor Jezierski

The Department of Slavic Languages and Literatures offers graduate courses in Russian language and literature and limited training in the language and literature of Poland.

Students should have sufficient preparation in the Russian language to enable them to read Russian classical literature in the original.

### For Seniors and Graduates

**201, 202. Russian Novel of the Nineteenth Century.** First semester: 1830-1870. Second semester: 1870-1900. Prerequisite: 161, 162, or equivalent. 6 units. *Krynski*

**205. The Structure of Polish in Relation to Russian.** Comparative and contrastive study of the two major Slavic languages. Emphasis on preparing students to read Polish literary texts. 3 units. *Krynski*

**206. Readings in Contemporary Polish Prose in the Original.** Stylistic analysis of aphoristic prose by Stanislaw Lec, philosophical allegories by Leszek Kolakowski and short stories by Slawomir Mrozek and Marek Hlasko. 3 units. *Krynski*

**207. Soviet Literature and Culture.** Literature since 1917. Readings in English from major works of prose, poetry, and drama. 3 units. *Jezierski*

**207P. Preceptorial.** Elective preceptorial for students enrolled in Slavic Languages and Literatures 207. *Jezierski*

**212. Pushkin.** Survey of life and works, his role as precursor of modern Russian literature. Readings in English and Russian. Prerequisite: Russian 101 or consent of instructor. 3 units. *Krynski*

**225S. Tolstoy.** *War and Peace* and other works. Prerequisite: Russian 175S or equivalent. 3 units. *Jezierski*

**227S. Gogol.** Life and works: short stories, dramas, and the novel. Readings in English or Russian. 3 units. *Jezierski*

**230. Chekhov.** Structural analysis of Chekhov's short stories and plays against the background of contemporary Realist, Impressionist, and Decadent trends in Russian literature. 3 units. *Jezierski*

**230P. Preceptorial.** Elective preceptorial for students enrolled in Slavic Languages and Literature 230. *Jezierski*

**232. Dostoevsky.** Emphasis on *Brothers Karamazov* and the theory of the novel. Prerequisite: Russian 176 or equivalent. 3 units. *Jezierski*

## Sociology

Professor Back, *Chairman* (268 Sociology-Psychology); Assistant Professor Campbell, *Director of Graduate Studies* (332 Sociology-Psychology); Professors Kerckhoff, Maddox, McKinney, Myers, Palmore, Portes, Preiss, Roy, Smith, and Tiryakian; Associate Professors House, Simpson, and Wilson; Assistant Professors Evers, Hirschman, McGee, and Rice

The department offers graduate work leading to a Ph.D. degree in sociology. Before undertaking advanced work in this department, a student must have completed a minimum of 12 semester hours of approved preliminary courses in sociology, and an additional 12 semester hours in related work. Applicants for admission should submit scores on the Graduate Record Examination, especially the Aptitude Test.

Increasingly the department is concentrating its training in three programs: Sociology of Human Development; Demography and Ecology; and Social Structure and Social Change. Students who enter without having chosen a program have their first year to do so if entering with the Bachelor's degree or their first semester if entering with a Master's degree. Each program has its own course requirements, but all share a six course requirement covering theory (281) and methodology (295), research methods and techniques (291, 292), and statistics (293, 294). In addition, each program has an informal seminar series and expects extensive student involvement in the research activities of program faculty. All students are expected to participate for training purposes in the teaching program of the department. In order to assure some breadth of training, all students are required to take at least two departmental courses outside the specific course requirements of both their chosen program and the departmental core requirement. Two or four additional courses outside the department in related work are also required.

There is a qualifying procedure after three semesters, or equivalent, to determine whether the student can proceed to the preliminary examination. The latter is an oral examination on a written paper that reviews substantive, theoretical, and empirical aspects of a special field chosen by the student and accepted by the student's examining committee. Further details concerning the general departmental program, the three specialized programs, departmental facilities, the staff, ongoing research, and various stipends available may be obtained from the Director of Graduate Studies.

### For Seniors and Graduates

**201. Social Change.** Causes, indicators, and consequences. Classical and contemporary theorists Marx, Weber, Sorokin, Parsons, Lenski, and others. 3 units. *Staff*

**202. Social Organization.** Contrasting conceptions with emphasis on the sustenance and evolution of social arrangements. 3 units. *Staff*

**225. Medical Sociology.** Current issues in the organization, development and the utilization of resources for health care. 3 units. *Back or Maddox*

**230. Social Aspects of Aging and Death.** Theories of human aging; social problems caused by increased longevity, discrimination against the aged, retirement, widowhood, and other role losses. Social-psychological factors in mortality, accidental death, suicide, and murder. 3 units. *Palmore*

**241. Social Stratification.** The nature of hierarchical and vertical differentiation for the economic, political, and prestige structures in modern societies. The interrelationship of class, status, and power strata and their influence on social institutions, personality structure, and group and individual behavior. The

transmission of inequality from one generation to the next. 3 units. *Campbell, Evers, Hirschman, or Roy*

**242. The Sociology of Occupations and Professions.** The social significance of work. Analysis of forces changing the contemporary occupational structure, typical career patterns of professions and occupations, and social organization of occupational groups. 3 units. *Roy or Simpson*

**243. Population Dynamics and Social Change.** Social scientific aspects of the determinants and consequences of population trends. 3 units. *Evers, Hirschman, or Myers*

**244. Human Ecology and Urban Systems.** Origins and development of human ecology theory, growth of cities and urban systems, residential segregation of social classes and racial and ethnic groups. 3 units. *Evers, Hirschman, Myers, or Smith*

**246. Population Policy.** Formation, effect, and evaluation. Historical examples of mortality, fertility, migration, and distribution policies. The Malthusian and neo-Malthusian controversies. Psychological, sociological, demographic, and political background. (Also listed as Public Policy Sciences 246.) 3 units. *Back*

**251. The Sociology of Modernization.** Theories and perspectives on the nature of modernization and modernity in Western and non-Western countries. 3 units. *Hirschman, Portes, or Tiryakian*

**254. Urbanization and Social Change.** Interactions between social structure and physical space in three contexts: (a) the re-emergence of cities in Medieval Europe; (b) the contemporary evolution of cities and their hinterlands in the United States; and (c) patterns of urbanization in the Third World. 3 units. *Portes*

**259. Religion and Social Change.** The role of religion in significant social changes in Western and non-Western societies; noninstitutional phenomena (charisma, prophecy, messianism, revivals, glossolalia). 3 units. *Tiryakian or Wilson*

**260. Science, Technology, and Society.** Science as a social phenomenon. Relations of science to technology and their articulation through public policy. Interaction of the institutions of science with other societal institutions. 3 units. (Also listed as Psychology 260.) *Bevan and McKinney*

**261. Science, Politics, and Government.** The structure and values of the scientific community, the mechanism and strategies of government, and their mutual interdependence in American society. (Also listed as Public Policy Sciences 255 and Psychology 261.) 3 units. *Bevan and McKinney*

**272. The Socialization Process.** Mechanisms and variations in socialization by position in the social structure (class, race, urban-rural); contributions made by various socialization agencies (family, school, peer groups, mass media) in Western society. 3 units. *Kerckhoff or McGee*

**275. Social Structure and Personality.** Processes by which social structures and social change (including class, modernization, societal and organizational membership) affect individual attitudes and behaviors. Nature and effect of stress, alienation, and other forms of incongruence between individuals and social structures. 3 units. *House or Portes*

**276. Small Groups and Social Life.** A systems theoretical approach. Basic group processes including communication, integration, sub-group formation, specialization, hierarchy, and leadership; different types, contexts and interrelations of groups. 3 units. *Back*

**278. Social Structure and the Life Cycle.** Relationship between age as a social characteristic and social interaction, with particular reference to adolescence and old age. 3 units. *Maddox*

**281. Seminar in Sociological Theory.** Development, convergence, and utilization of sociological theories. 3 units. *Tiryakian or Wilson*

**291. Research Methods and Techniques I.** Principles and methods of collecting and utilizing questionnaire and survey data. Applications of methods, secondary analysis, laboratory and field experimentation, observation and other types of research. Prerequisite: Sociology 132 or 293, or equivalent. 3 units. *Evers, House, Portes, or Smith*

**292. Research Methods and Techniques II.** Principles, methods, and applications of interviewing, participant observation, content analysis, unobtrusive measures, historical and archival analysis. Issues of reliability, validity, quantification, multiple methodologies, and the interrelationship of theory and method. 3 units. *McGee or Roy*

**293. Introductory Statistical Analysis.** Basic descriptive statistics, regression and correlation, t-tests and the analysis of variance, chi square techniques, and other topics. Stress on practical applications. Statistical computing using SPSS and other programs. 3 units. *Campbell or Rice*

**294. Intermediate Statistical Analysis.** The general linear model and its application in methods of multivariate statistical analysis: analysis of variance and covariance, multiple regression and path analysis, and log-linear models for categorical data. Statistical computing using SPSS and other programs. Prerequisite: Sociology 293 or equivalent. 3 units. *Campbell or Rice*

**295. Methodology in Sociology.** The nature of scientific method, as well as alternative paths to knowledge, as they apply to sociology. Conceptualization, hypothesis formation, and definition. The research process as a decision-making situation for both general research design and specific techniques. The process and logic of data analysis. Relations of theory and research are stressed. 3 units. *Back or Smith*

**298S, 299S. Seminar in Selected Topics.** Substantive, theoretical, or methodological topics. 3 graduate units each semester. *Staff*

### For Graduates

**301. Seminar in Human Fertility.** Special topics in human fertility including: theory of demographic transition, fertility in Latin America, design and evaluation of family planning programs, fertility and problems of modernization, and family structure and fertility. 3 units. *Back*

**302. Seminar in Migration.** Special topics in migration including: Latin American rural-urban migration, urban migration policy, contemporary migration theories, and international migration. 3 units. *Myers or Smith*

**325. Social Aspects of Mental Illness and Treatment.** An examination and critique of sociological research and theory in the epidemiology, etiology, and treatment of mental illness. Such topics as the effect of mental illness on the family, the structure and function of various treatment systems, and major problems of methodology will receive emphasis. 3 units. *Back or Preiss*

**341. Special Problems of Complex Systems.** (a) *Industrial and Professional Systems.* Analysis of problems of organization of work in such diverse settings as



industrial plants, hospitals, and public administration groups. Problems of decision-making, recruitment, allocation of authority, informal organization, inter-organizational relations. 3 units. *McKinney, Roy, or Simpson*

(b) *Mass Communications*. Theoretical problems in defining and distinguishing communication, communicative acts, communication processes, and communication systems. Work aimed toward the derivation of models and theories for each of these will be pursued. 3 units. *Smith*

(c) *Urban Society*. Analysis of the varying mechanisms through which urban society is integrated, how urbanites develop a sense of identification with the community, the extent and mode of social dominance of the city in the larger society. 3 units. *Myers or Smith*

**344. Workshop on Computer Models of Social Systems.** The methodology of building mathematical and logical models of social systems and computer simulation experiments with such models. The types of models and social systems surveyed have applications in business administration, economics, education, political science, psychiatry, psychology, and sociology. Participants in the workshop will develop and conduct simulation experiments with a model of some complex social system, such as a city, state, region, or nation. (Also listed as Economics 344 and Computer Science 344.) 3 units. *Naylor*

**345, 346. Demographic Techniques I and II.** Measurement and methodology in demography. The first course deals primarily with basic measurement techniques including standardization, construction of the life table, period and cohort measures of fertility, and introduction to classical population theory. The second is devoted to the analysis of complex models such as family building models and growth and projection models and the preparation of a research topic. (Also listed as Economics 345, 346.) 3 units each semester. *Evers or Myers*

**349, 350. Seminar in Selected Topics of Demography and Ecology.** Social, economic, and environmental determinants or consequences of population structure and trends. A broad, multidisciplinary, cross-national and processual perspective is stressed. 3 units. *Staff*

**373, 374. Social Psychological Issues in Sociology.** Detailed exploration of selected problem areas such as the theory and measurement of social attitudes, role discontinuity and personality disorders, applications of reference group theory, the socialization process. 3 units each semester. *Back, House, Kerckhoff, and Preiss*

**385. Seminar in Sociological Theory.** Analysis of methodological and substantive problems in utilizing comprehensive, middle-range, and discrete theories in varied sociological areas. Major emphasis on the use of theory in empirical research. Prerequisite: Sociology 281 or equivalent. 3 units. *McKinney and Tiryakian*

**386. Seminar in Sociological Theory.** Focuses on the theoretical and research implications of existential phenomenology, drawing from such sources as Husserl, Merleau-Ponty, and Schutz. Attention will be given to recent sociological interests in this area (e.g., ethnomethodology). Prerequisite: Sociology 281 or equivalent. 3 units. *Tiryakian*

**390. Seminar in Field Methods of Sociological Research.** The primary aims of this course will be two-fold, (a) to consider at length and in detail various procedures and problems of observing human behavior in natural group, organizational, and community settings, and (b) to give the neophyte researcher elementary training in first-hand observation and face-to-face interviewing. 3 units. *Roy*

**392. Individual Research in Sociology.** Students will conduct on an individual basis research designed to evaluate a sociological hypothesis of their choice. The

process must be completed by preparation of a report on this research in adequate professional style. Prerequisite: Sociology 295 or consent of instructor. 3 units. *Back or Smith*

**397, 398. Seminar in Special Research.** 3 units each semester. *Staff*

**402. Interdisciplinary Seminar in the History of the Social Sciences.** A survey of the theories, methods and tools applied to problems in the history of the social sciences. 3 units. *Goodwin, Holley, and Spragens*

## Zoology

Professor Fluke, *Chairman* (227 Biological Sciences); Professor Wainwright, *Director of Graduate Studies* (024 Biological Sciences); Professors Bailey, Costlow, Gillham, Gregg, Klopfer, Livingstone, Nicklas, Schmidt-Nielsen, Tucker, and K. Wilbur; Associate Professors Barber, Lundberg, Sutherland, Vogel, and Ward; Adjunct Associate Professor Schmidt-Koenig; Assistant Professors Forward, McClay, Nijhout, Storey, and H. Wilbur

The Department of Zoology manages a variety of programs tailored to individual needs of students seeking A.M. or Ph.D degrees.

In general, students entering the department will be equipped to pursue advanced degrees if they have completed an undergraduate major in biology along with some formal training in college-level chemistry, mathematics, physics, and foreign languages.

Nevertheless, in recognition and support of the modern trend toward interdisciplinary research, the department is prepared to accept promising students with less orthodox academic backgrounds and is ready to encourage any student wishing to undertake a program of study leading, in effect, to an interdisciplinary degree sponsored by the department.

Thus, all students are urged to search widely in the *Bulletin of Undergraduate Instruction* and the *Bulletin of the Graduate School* for information about the intellectual resources of the University. Special attention should be given to announcements of the Departments of Anatomy, Anthropology, Biochemistry, Botany, Chemistry, Geology, History, Mathematics, Microbiology and Immunology, Philosophy, Physiology and Pharmacology, Psychology, Sociology, and Zoology; announcements of the Schools of Engineering and Forestry should also be consulted.

### For Seniors and Graduates

The *L* suffix on a zoology course number indicates that the course includes a laboratory.

**201L. Animal Behavior.** Emphasis on recent physiological and developmental studies. Prerequisites: physiology, genetics, and evolution, or consent of instructor. 4 units. *Klopfer*

**202L. Introduction to Comparative Behavior.** Behavior as revealed by physiological, evolutionary, and ecological studies with primary emphasis on marine groups. Prerequisite: one course in physiology. Given at Beaufort. 6 units. *Salmon (Visiting Summer Faculty)*

**203L. Marine Ecology.** Application of ecological theory to marine systems. Mathematical properties of population growth and species interactions; field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current scientific publications. Prerequisites: introductory

biology or invertebrate zoology, and calculus; knowledge of statistics is recommended. Given at Beaufort. 6 units. *Sutherland*

**204L. Population and Community Ecology.** Theoretical ecology emphasizing the evolution of life cycles, mathematical properties of systems of interacting species, and mechanisms of species interactions. Laboratories emphasize biometrical and experimental testing of ecological theory in relation to a variety of habitats. Individual projects and weekend field trips. Prerequisites: Zoology 103 and calculus; senior or graduate standing, or consent of instructor. 4 units. *H. Wilbur*

**205. Elements of Theoretical Biology.** An introduction to elementary mathematical biology, conceived as the study of axiomatized mathematical theories and their biological models. Prerequisites: introductory biology and mathematics, or consent of instructor. 3 units. *Gregg*

**214L. Biological Oceanography.** Impact of biological processes on the physical and chemical character of the environment and the regulating role of abiotic processes on organic productivity. Factors regulating primary and secondary productivity with the estuary and ocean as examples. Emphasis on design and execution of directed research. Prerequisite: consent of instructor; introductory biological or chemical oceanography is recommended. Given at Beaufort. 6 units. *Barber*

**216L. Limnology.** Lakes, ponds, and streams; their origin, development, geochemistry, energy balance, productivity, and the dynamics of plant and animal communities. Lectures, field trips, and laboratories. Offered in alternate years. Prerequisites: introductory biology, Chemistry 12, physics, and Mathematics 31, or consent of instructor. 4 units. *Livingstone*

**218L. Paleobiology.** The dynamics of past ecosystems; climatology and ecological geography of the past few million years; laboratory study of lake-bed deposits with emphasis on Quaternary pollen grains. Prerequisites: a course in ecology and consent of instructor. 4 units. *Livingstone*

**222L. Entomology.** The biology of terrestrial arthropods. Lectures, laboratories, and field trips. Prerequisite: introductory biology. 4 units. *Nijhout*

**224L. Vertebrate Natural History.** Life histories, adaptations, ecology, and classification of vertebrate animals. Prerequisite: Zoology 108. 4 units. *Bailey*

**229. Morphogenetic Systems.** Lectures on the interplay of theory and experiment in twentieth-century developmental biology. Prerequisite: introductory biology. 3 units. *Gregg*

**235. Evolutionary Systematics.** Evolutionary mechanisms in speciation and phylogeny in plants and animals: geographic and reproductive isolation, breeding systems, hybridization, homology, convergence, and extinction. Assessment of modern techniques (cytotaxonomy, chemotaxonomy, numerical taxonomy) in classification. Complements Botany 186, Botany 286, Zoology 186, Zoology 286. Lectures. Prerequisite: introductory biology. (Also listed as Botany 135, Botany 235, and Zoology 135.) 3 units. *Bailey, Lundberg, and Stone (Botany)*

**235L. Evolutionary Systematics.** See Zoology 235. Lectures and laboratories. 4 units. *Bailey, Lundberg, and Stone (Botany)*

**238L. Systematic Zoology.** Theory and practice of collection, identification, and classification of animals. Prerequisite: introductory biology. 4 units. *Bailey*

**239S. Biogeography.** Old and new distributional concepts of animals and plants involving physical geography, geology, paleontology, systematics, evolution,



population dynamics, and dispersal. Prerequisite: consent of instructor. 3 units. *Bailey*

**245. Radiation Biology.** Actions of ionizing and excitational radiations on life processes; biological use of radioactive tracers; nucleonics. Prerequisites: physics, Mathematics 32, and Chemistry 12. 3 units. *Fluke*

**246. Physical Biology.** Biomechanics, physical optics, and other physical topics applied to living organisms and systems at various levels of organization. Prerequisites: Mathematics 32, Chemistry 12, physics, and one biology course beyond the introductory level, or consent of instructor. 3 units. *Fluke and Wainwright*

**250L. Physiological Ecology of Marine Animals.** The physiology of marine animals as related to environmental factors of salinity, temperature, oxygen, and light. Prerequisite: a course in physiology. Given at Beaufort. 6 units. *Forward*

**252. Comparative Physiology.** The physiological mechanisms of animals studied on a comparative basis. Prerequisite: Zoology 151 or equivalent. 4 units. *Schmidt-Nielsen*

**254S. Fluid Flow and Living Systems.** Physical principles of low speed flow; applications to locomotion, circulation, dispersal, ventilation, filtration, and heat dissipation. Prerequisites: physics and Mathematics 31, or equivalents. 3 units. *Vogel*

**258L. Laboratory Research Methods.** Radioisotope methods, spectrophotometry, light microscopy, transmission and scanning electron microscopy, X-ray diffraction, gel electrophoresis, isolation of cell components, and other methods. Students may select methods according to their interests and research needs. Prerequisite: consent of instructor. Credit to be arranged. 1 to 4 units. *K. Wilbur and Staff*

**260. Advanced Cell Biology.** Structural and functional organization of cells and their components, emphasizing current research problems and prospects. Prerequisites: introductory cell biology (or genetics and consent of instructor); introductory biochemistry is recommended (may be taken concurrently). 3 units. *Nicklas, K. Wilbur, and Staff*

**262L. Cytological Materials and Methods.** Cytological analysis, with emphasis on chromosome studies using advanced optical, cytochemical, and experimental techniques. Offered in alternate years. Prerequisite: Zoology 260 or equivalent (may be taken concurrently). 3 units. *Nicklas*

**265S, 266S. Seminar in Chromosome Biology.** Current research in chromosome structure and function, mitosis, and meiosis. Prerequisites: a course in cell biology or genetics, and consent of instructor. (Also listed as Anatomy 265, 266.) 2 units each semester. *Moses (Anatomy) and Nicklas*

**274L. Marine Invertebrate Zoology.** Structures, functions, and habits of invertebrate animals under natural and experimental conditions. Field trips included. Not open to students who have had Zoology 275. Prerequisite: introductory biology. Given at Beaufort. 6 units. *Barnes (Visiting Summer Faculty)*

**275L. Invertebrate Zoology.** The biology of invertebrates. Lectures, and laboratories, and field trips. Not open to students who have had Zoology 173, 174, or 274. Prerequisite: introductory biology. (Also listed as Zoology 175.) 4 units. *Nijhout*

**277L. Endocrinology of Marine Animals.** Control of growth, regeneration, reproduction, metabolism, and other aspects of physiology of marine animals, pri-



marily invertebrates. Offered in alternate years. Prerequisite: one course in physiology. Given at Beaufort. 6 units. *Staff*

**278L. Invertebrate Embryology.** Lectures, readings, and laboratory work dealing with rearing, development, and life histories of invertebrates. Prerequisite: consent of instructor. Given at Beaufort. 6 units. *Staff*

**280. Principles of Genetics.** Structure and properties of genes and chromosomes and evolution of genetic systems. Prerequisites: introductory biology, Chemistry 12, and Mathematics 31, or equivalents. (Also listed as Botany 180, Zoology 180, and under the University Program in Genetics.) 3 units. *Antonovics (Botany), Boynton (Botany), and Gillham*

**286. Evolutionary Mechanisms.** Evolutionary mechanisms in population ecology and population genetics of plants and animals: natural selection, adaptation, species interactions, mating systems, fitness concepts, and genetic divergence. Complements Botany 135, Botany 235, Zoology 135, Zoology 235. Prerequisite: introductory biology. (Also listed as Botany 186, Botany 286, Zoology 186, and under the University Program in Genetics.) 3 units. *Antonovics (Botany) and H. Wilbur*

**288S. The Cell in Development and Heredity.** A seminar on topics of current interest and controversy. Prerequisites: a course in genetics and consent of instructor. (Also listed as Anatomy 288.) 2 units. *Counce (Anatomy)*

**295S, 296S. Seminar.** Topics, instructors, and course credit to be announced each semester. *Staff*

#### For Graduates

**351, 352. Departmental Seminar.** A weekly meeting of graduate students and faculty to hear and discuss research reports. 1 unit credit by arrangement. *Staff and Invited Lecturers*

**353, 354. Research.** To be carried on under the direction of the appropriate staff members. Hours and credit to be arranged. *Staff*

**355, 356. Seminar.** One or more seminar courses in particular fields are given each semester by various members of the staff. 2 units. *Staff*

**360, 361. Tutorials.** Students will write essays based on reading of literature. Essays will be discussed and critically evaluated in meetings. 2 units each semester. *Staff*

**Genetics, The University Program.** Genetics courses offered by the Department of Zoology are part of The University Program in Genetics; see announcement in this *Bulletin*.

**Marine Laboratory.** Consult Marine Sciences in this *Bulletin* for offerings at the Duke University Laboratory.

**Program in Tropical Biology.** Fellowships are available for travel and subsistence in field-oriented programs in Latin America. Refer to the section Organization for Tropical Studies in this *Bulletin* in the chapter on Special and Cooperative Programs.

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# Bulletin of Duke University

Undergraduate Instruction

1977-1978





# Bulletin of Duke University

## Undergraduate Instruction

Trinity College of Arts and Sciences  
The School of Engineering  
The School of Nursing

1977-1978

Durham, North Carolina 1977

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# University Calendar—1977-1978

## Fall 1977

### September

- 1 Thursday—Freshman Orientation begins: assemblies for all new undergraduate students
- 6 Tuesday, 9:00 a.m.—Fall semester classes begin
- 7 Wednesday, 4:00-6:00 p.m.—Drop/Add begins, Indoor Stadium
- 8, 9 Thursday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building
- 12-16 Monday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building

### October

- 14 Friday—Last day for reporting midsemester grades
- 24-27 Monday-Thursday—Registration for spring semester, 1978

### November

- 22 Tuesday, 6:00 p.m.—Thanksgiving recess begins
- 28 Monday, 9:00 a.m.—Classes are resumed

### December

- 11 Sunday—Founders' Day
- 12 Monday, 6:00 p.m.—Fall semester classes end
- 13, 14 Tuesday-Wednesday—Reading period
- 15 Thursday—Final Examinations begin
- 21 Wednesday—Final Examinations end

## Spring 1978

### January

- 6 Registration and matriculation of new undergraduate students
- 9 Monday, 9:00 a.m.—Spring semester classes begin
- 10 Tuesday, 4:00-6:00 p.m.—Drop/Add begins, Indoor Stadium
- 11-13 Wednesday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building
- 16-20 Monday-Friday, 8:30-12:30 and 2:00-4:00 p.m.—Drop/Add continues, 103 Allen Building

### February

- 17 Friday—Last day for reporting midsemester grades

### March

- 3 Friday, 6:00 p.m.—Spring recess begins
- 13 Monday, 9:00 a.m.—Classes are resumed
- 27-29 Monday-Wednesday—Registration for fall semester, 1978 and summer, 1978

### April

- 21 Friday, 6:00 p.m.—Spring semester classes end
- 22-24 Saturday-Monday—Reading period
- 25 Tuesday—Final examinations begin

### May

- 1 Monday—Final Examinations end
- 6 Saturday—Commencement begins
- 7 Sunday—Graduation exercises, conferring of degrees

# University Administration

## General Administration

Terry Sanford, J.D., LL.D., D.H., L.H.D., D.P.A., *President*  
A. Kenneth Pye, LL.M., *Chancellor*  
Frederic N. Cleaveland, Ph.D., *Provost*  
Charles B. Huestis, *Vice President for Business and Finance*  
William G. Anlyan, M.D., *Vice President for Health Affairs*  
Juanita M. Kreps, Ph.D., *Vice President*  
J. David Ross, J.D., *Vice President for Institutional Advancement*  
Stephen Cannada Harward, A.B., C.P.A., *Treasurer and Assistant Secretary*  
J. Peyton Fuller, A.B., *Assistant Vice President and Corporate Controller*  
Harold W. Lewis, Ph.D., *Vice Provost and Dean of the Faculty*  
John C. McKinney, Ph.D., *Vice Provost and Dean of the Graduate School*  
John M. Fein, Ph.D., *Vice Provost and Dean of Trinity College of Arts and Sciences*  
Ewald W. Busse, M.D., *Associate Provost and Dean of Medical and Allied Health Education, School of Medicine*  
Roscoe R. Robinson, M.D., *Associate Vice President for Health Affairs and Chief Executive Officer of Duke Hospital*  
Frederick C. Joerg, M.B.A., *Assistant Provost for Academic Administration*  
Anne Flowers, Ed.D., *Assistant Provost for Educational Program Development*  
William J. Griffith, A.B., *Assistant Provost and Dean of Student Affairs*  
William C. Turner, Jr., M.Div., *Assistant Provost and Dean of Black Affairs*  
Richard L. Wells, Ph.D., *Assistant Provost and Associate Dean of Trinity College of Arts and Sciences*  
Joel L. Fleishman, LL.M., *Vice Chancellor for Public Policy Education and Research; Director of the Institute for Policy Sciences and Public Affairs*  
Connie R. Dunlap, A.M.L.S., *Librarian*  
William E. King, Ph.D., *University Archivist*  
Clark R. Cahow, Ph.D., *University Registrar*  
Robert N. Sawyer, Ed.D., *University Educational Planning Officer and Director of Summer Educational Programs*  
Rufus H. Powell, LL.B., *Secretary of the University*  
Charles Linn Haslam, J.D., *University Counsel*

## Undergraduate Administration

John M. Fein, Ph.D., *Vice Provost and Dean of Trinity College of Arts and Sciences*  
Ruby L. Wilson, R.N., Ed.D., *Dean of the School of Nursing*  
Aleksandar Vesić, D.Sc., *Dean of the School of Engineering*  
Richard L. Wells, Ph.D., *Assistant Provost and Associate Dean of Trinity College of Arts and Sciences*  
William J. Griffith, A.B., *Assistant Provost and Dean of Student Affairs*  
William C. Turner, Jr., M.Div., *Assistant Provost and Dean of Black Affairs*  
Clark R. Cahow, Ph.D., *Director of Undergraduate Admissions and Financial Aid*  
Eleanor Bradsher, *Assistant to the Dean of the School of Nursing*  
Virginia S. Bryan, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences and Coordinator for Curriculum*  
Dorothy J. Brundage, M.N., *Coordinator of the Undergraduate Program, School of Nursing*  
Richard L. Cox, B.D., Th.M., *Associate Dean of Student Affairs*  
John Cromer, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*  
James Douthat, B.D., *Associate Dean of Student Affairs*

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 Joanne E. Hall, M.S., *Coordinator of the Graduate Program, School of Nursing*  
 Shirley Hanks, A.B., *Career Counselor*  
 Marcia Ladd, M.Ed., *Assistant Dean of Trinity College of Arts and Sciences*  
 Jane Monroe, B.S.N., *Associate Director of Continuing Education*  
 Elaine T. Nagey, M.Ed., *Staff Assistant for Academic Affairs of the School of Nursing*  
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 Ella E. Shore, M.R.E., M.A., *Dean of Student Affairs of the School of Nursing*  
 Howard A. Strobel, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences and Coordinator for Federation Programs*  
 Gerald L. Wilson, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences and Coordinator for the Deans' Staff*  
 Ellen W. Wittig, Ph.D., *Assistant Dean of Trinity College of Arts and Sciences*





# Boards of Visitors

## The School of Engineering

- Charles F. Ballenger, *President, Ballenger Corporation*  
Theodore G. Birdsall, *Professor, Department of Electrical and Computer Engineering, University of Michigan*  
George Bugliarello, *President, Polytechnic Institute of New York*  
Paul F. Chenea, *Vice President, General Motors Corporation*  
Harold L. Flowers, *Program Manager, McDonnell Douglas Astronautics Company*  
George R. Herbert, *President, Research Triangle Institute*  
William H. Huggins, *Westinghouse Professor, Department of Electrical Engineering, Johns Hopkins University*  
Kenneth H. Keller, *Professor, Department of Chemical Engineering and Materials Science, University of Minnesota*  
William S. Lee, *Vice President for Engineering and Construction, Duke Power Company*  
A. I. Mlavsky, *Executive Vice President, Mobil-Tyco, Solar Energy Corporation*  
Nathan M. Newmark, *Professor, Department of Civil Engineering, University of Illinois*  
Simon Ostrach, *Wilbert J. Austin Distinguished Professor of Engineering, Case Western Reserve University*  
Robert H. Pinnix, *President, R. H. Pinnix, Inc.*  
William M. Siebert, *Professor, Department of Electrical Engineering, Massachusetts Institute of Technology*  
Wilbur S. Smith, *Wilbur Smith and Associates, Consulting Engineers*  
W. Brewster Snow, *Consulting Engineer, Plainfield, New Jersey*  
F. W. Steckmest, *Consultant, Public Affairs, Shell Oil Company*  
Howard M. Winterson, *President, Combustion Engineering, Inc.*

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Edward H. Benenson, *President, Benenson Management Company, Inc.*  
Earl W. Brian, *Secretary, Health and Welfare Agency of California*  
Shirley Chater, *Vice Chancellor, Academic Affairs and Professor of Nursing, University of California at San Francisco*  
John A. D. Cooper, *President, Association of American Medical Colleges*  
E. Laurence Davis III, *State Senator, Winston-Salem, North Carolina*  
Harry Eagle, *Associate Dean, Albert Einstein College of Medicine*  
James R. Felts, Jr., *Executive Director, Hospital and Child Care Sections, Duke Endowment*  
Loretta Ford, *Dean and Director of Nursing, University of Rochester*  
David A. Hamburg, *Reed Hodgins Professor of Psychiatry and Human Biology, Stanford University; President, Institute of Medicine*  
C. Henry Kempe, *Chairman and Professor of Pediatrics, University of Colorado*  
John K. Knowles, *President, Rockefeller Foundation*  
Alexander Leaf, *Chairman of the Department of Medicine, Harvard University Medical School*  
William H. Muller, *Chairman, Department of Surgery, University of Virginia*  
Raymond D. Nasher, *The Raymond D. Nasher Company*  
George Pallade, *Nobel Laureate, Yale University*  
William R. Pitts, *Physician, Charlotte, North Carolina*  
Anne R. Somers, *Associate Professor of Community Medicine, Rutgers University Medical School*  
Edwin Whitehead, *Chairman of the Board, Technicon, Inc.*

# General Information





## Duke University

In 1839 a group of citizens from Randolph and adjacent counties in North Carolina assembled in a log schoolhouse to organize support for a local academy founded a few months earlier by Brantley York. Prompted, they said, by "no small share of philanthropy and patriotism," they espoused their belief that "ignorance and error are the banes not only of religious but also civil society which rear up an almost impregnable wall between man and happiness." The Union Institute, which they then founded, was reorganized in 1851 as Normal College to train teachers, and again in 1859 as Trinity College, a liberal arts college, which later moved from the fields of Randolph County to the growing city of Durham, North Carolina. Trinity College was selected by James B. Duke as the major recipient of a fortune when, in 1924, he provided endowment funds for the university that would bear his name.

The old Trinity College had, like almost all institutions in America at the time it was founded, been restricted to men. In 1896, Washington Duke gave an endowment with the condition that women be admitted "on equal footing with men." Thereafter, women were educated in Trinity College, and in 1930 The Woman's College was established as a separate college. Trinity College and The Woman's College continued as coordinate colleges for over forty years. To assure that women were indeed admitted "on equal footing with men," and to recognize that the education which men and women had received at Duke had long taken place in the same classrooms, the University merged these coordinate colleges in 1972 to form Trinity College of Arts and Sciences, an administrative unit responsible for undergraduate admissions, programs of instruction, academic and personal counseling, and residential life. The A.B. and B.S. degrees may be earned in the College.

Instruction in engineering started at Normal College in 1851 and was continued at Trinity College as an option in the arts and sciences program. With the establishment of Duke University in 1927, the Departments of Civil and Electrical Engineering were formed, and a Department of Mechanical Engineering was added four years later. The three engineering departments were joined to form the Division of Engineering as a separate administrative unit of the University. In 1939 this Division was renamed the College of Engineering, which in 1966 became a professional school of engineering. The Division of Biomedical Engineering was added to the School of Engineering in 1967, and it was recognized as a department in 1971.

In 1974 the name of the Mechanical Engineering Department was changed to Mechanical Engineering and Materials Science. All four departments offer courses leading to B.S.E., M.S., and Ph.D. degrees.

The School of Nursing was established in 1931 in association with the School of Medicine and Duke Hospital. The three-year curriculum led to the Diploma in Nursing, but students were required to have a minimum of one and preferably two years of acceptable college credit prior to entry into the School. Individuals completing two years of college in addition to the three-year nursing program were awarded a Bachelor of Science in Nursing degree. From 1944 until 1957 the Bachelor of Science in Nursing Education degree was offered in cooperation with the Department of Education. A four-year program leading to the degree of Bachelor of Science in Nursing was approved by the University Board of Trustees in 1953, and in 1958 a graduate program was initiated. The School of Nursing presently offers courses leading to B.S.N. and M.S.N. degrees.

As the University developed around the core of undergraduate colleges and schools, the Graduate School expanded in areas of instruction and research. The School of Law of Trinity College became the Duke University School of Law, and other professional schools were established. The Divinity School was organized in 1926, the School of Medicine in 1930, the School of Forestry in 1938, and the Graduate School of Business Administration in 1969. In 1974, the School of Forestry was renamed the School of Forestry and Environmental Studies.

Duke, a privately supported, church-related (Methodist) University, has over 9,000 students enrolled in degree programs. These students represent nearly every state and sixty foreign countries; Duke has more than 54,000 alumni in all fifty states and in many foreign countries. The University is a member of the North Carolina Association of Colleges and Schools, the Southern Association of Colleges and Schools, and the Association of American Universities.

From academy to university some of the basic principles have remained constant. The Duke University motto, *Eruditio et Religio*, reflects a fundamental faith in the union of knowledge and religion; the advancement of learning; the defense of scholarship; the love of freedom and truth; a spirit of tolerance; and a rendering of the greatest service to the individual, the state, the nation, and the church. Through changing generations of students, the objective has been to encourage individuals to achieve, to the extent of their capacities, an understanding and appreciation of the world in which they live, their relationship to it, their opportunities, and their responsibilities.

## Resources of the University

**The Faculty.** The University faculty of approximately 1,250 maintains a tradition of personal attention to students. Many members of the faculty are, or have been, national leaders in their various professional organizations, as well as consultants to industry, government, or foundations; their contributions to scholarship include many publications related to their research. To honor outstanding faculty members, the University has established more than thirty James B. Duke professorships, as well as other named professorships.

**The Library System.** The libraries of the University consist of the Perkins Library and its eight branches on campus: Biology-Forestry, Chemistry, Divinity, the East Campus Library, Engineering, Music, Physics-Mathematics, the Undergraduate Library, and the Pearse Memorial Library at the Duke Marine Laboratory in Beaufort; the Law Library; and the Medical Center Library. In June, 1976, these libraries contained approximately 2,700,000 volumes and ranked eighteenth in size among academic libraries in the United States. More than 14,000 periodicals, 20,000 serials, and 200 newspapers are received regularly. The collection includes

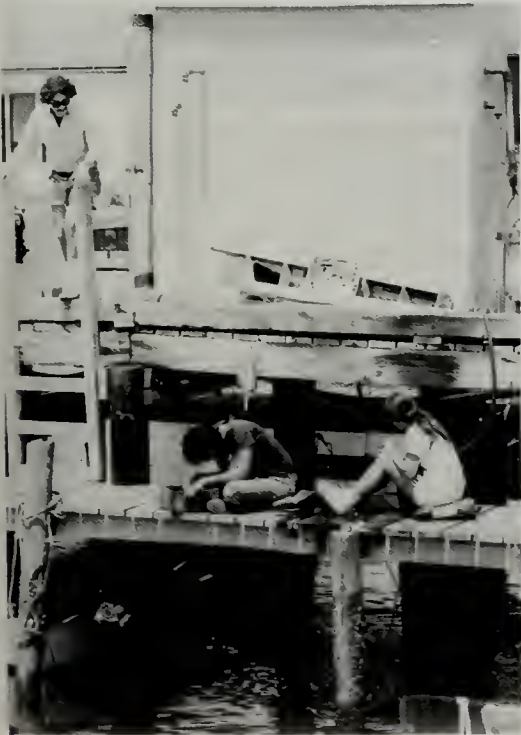


about 5,000,000 manuscripts, 70,000 maps, 28,000 sheets of music, and 235,000 rolls or sheets of microtext.

*The William R. Perkins Library.* The William R. Perkins Library—the main library of the University—houses most of the books and journals in the humanities and social sciences, large files of United States federal and state documents, public documents of many European and Latin American countries, publications of European academies and learned societies, and special collections from South Asian, Far Eastern, and Slavic countries. The newspaper collection, with 15,000 volumes and 30,000 reels of microfilm, has several long eighteenth-century files, strong holdings of nineteenth-century New England papers and antebellum and Civil War papers from North Carolina, South Carolina, and Virginia, as well as many European and Latin American papers. The manuscript collection of approximately five million items is particularly strong in all phases of the history, politics, and social and economic life of the South Atlantic region; it also includes significant papers in English and American literature. The rare books collection contains many scarce and valuable materials covering a broad range of fields, and the Latin and Greek manuscripts constitute one of the outstanding collections of its kind in the United States. The collection of Confederate imprints is the largest in the country.

The Undergraduate Library houses a small collection of books designed to meet the needs of undergraduates and contains the required reading materials placed on reserve for undergraduate courses. The branch libraries serve the academic disciplines whose names they bear. The East Campus Library is primarily for undergraduate use, but it also contains the principal collections for graduate and undergraduate study in art.

Tours of the Perkins Library are given frequently during Orientation Week and upon request throughout the year. Information about other campus libraries may be obtained from the staff in each of the libraries. Handbooks about library services and facilities are also available in each of the libraries.





*The Medical Center Library.* The Medical Center Library, located in the Seeley G. Mudd Communications Center and Library Building, provides the services and collections necessary to further educational, research, and clinical activities in the medical field. Services are available to the students, faculty, and staff of the Schools of Medicine and Nursing; of the Division of Allied Health; of Duke Hospital; and of the graduate departments in the basic medical sciences. Other students and faculty needing access to biomedical literature may apply for privileges upon application to the Chief of Readers' Services.

Over 160,000 volumes are available, including the Trent Collection in the History of Medicine. Approximately 2,200 journal titles are received, in addition to extensive back files of older materials. The library has several types of audiovisual materials and equipment. With the exception of certain items shelved on reserve, these materials have been integrated into the general book and journal collections and are listed in the card or journal catalogues. The Frank Engel Memorial Collection consists of a small group of books on non-medical subjects for general reading, together with several newspapers and popular magazines. Traditional reference services are supplemented by on-line bibliographic systems and computer-produced specialized indexes.

The uniform borrowing privileges apply to all registered users. Details of loan and other services may be found in the guide which is published each year and is available at the library.

**The School of Law Library.** The School of Law Library, with approximately 200,000 volumes, serves both the University and the local legal community. The collection contains nearly all reported decisions of the federal, state, and territorial courts of the United States, British Commonwealth, and representative foreign jurisdictions. It also includes the constitutions, codes, statutes, and subsidiary legislative publications of all these jurisdictions, as well as many digests, indexes, bibliographies, and related research tools. A large section of the library collection is devoted to treatises on all phases of law and legal sciences, as well as to materials in the fields of history, economics, government, and other social and behavioral sciences relevant to legal research. There are files of selected federal documents, and since 1970 a complete set of congressional materials has been maintained. The Christie Jurisprudence Collection is located in the main reading room. Other collections include legal history, administrative materials, intellectual property, criminal procedure, school law, and briefs of the U.S. Supreme Court, the Fourth Circuit Court of Appeals, the North Carolina Supreme Court, and the North Carolina Court of Appeals. Undergraduate and graduate students whose course of study requires access to legal literature are welcome to use the collections.

**University Archives.** The Duke University Archives, the official archival agency of the University, collects, preserves, and administers the records of the University having continuing administrative or historical value. The institutional archives, which also include published material, photographs, papers of student groups and faculty, and selected memorabilia, are available for research under controlled conditions in 341 Perkins Library.

**Computation Center.** The Duke University Computation Center provides the University faculty and students with a facility for research and instruction. The center is presently equipped with an IBM 370/135 computer (393 thousand bytes of memory, one 3330-type disk facility, three tape drives, two card readers, three printers, and a digital plotter), which is connected by a high-speed microwave link to an IBM 370/165 computer (four million bytes of memory, one 2314 and two 3330-type disk facilities, seven tape drives, card reader, and printer) located at the Triangle Universities Computation Center (TUCC)—a nonprofit corporation formed jointly by Duke University, North Carolina State University at Raleigh, and the University of North Carolina at Chapel Hill—in the Research Triangle Park. TUCC also has a Hewlett-Packard 2000F computer which provides BASIC interactive computing. Duke has three medium-speed terminals (card reader and printer), located in the Engineering Building, the Biological Sciences Building, and the Sociology-Psychology Building, as well as several other low-speed keyboard terminals, connected to TUCC.

All users of the Computation Center facilities are urged to obtain funds to pay for computer services. Users unable to obtain grant funding may ask for financial support from their departments when applying for services. More specific information regarding Duke computing facilities may be obtained from the Director of the Computation Center.

**Science Laboratories.** In addition to the teaching and research laboratories in the departments of natural and social sciences and in the Schools of Engineering and Nursing, there are other facilities in which some advanced undergraduates work on individual projects. These include the Duke University Marine Laboratory in Beaufort, North Carolina; the Highlands Biological Laboratory in Highlands, North Carolina; the phytotron of the Southeastern Plant Environment Laboratories, located on the Duke campus; the Duke Forest, adjacent to the campus; and the Triangle Universities Nuclear Laboratory, also on the campus.

**School of Nursing Instructional Facilities.** Facilities for instruction in the School of Nursing include resources in the undergraduate college, as well as in pro-



fessional and graduate schools of Duke University and in the clinical facilities of Duke Hospital, Durham Veterans Administration Hospital, Lenox D. Baker Cerebral Palsy Hospital, Durham City-County Health Department, John Umstead Hospital, Johnson County Health Department, and other health agencies in the vicinity.

## The Undergraduate College and Schools

In Trinity College of Arts and Sciences and the Schools of Engineering and Nursing, instruction is offered by University faculty who engage in research and in graduate and undergraduate teaching. Duke offers its undergraduates the opportunity to study with many internationally recognized authorities in their disciplines and with faculty members who are jointly committed to undergraduate instruction and to the advancement of knowledge. The University recognizes that students learn not only through formal lectures, but also through the interplay of ideas among faculty members and students; thus, it offers undergraduates opportunities to test their ideas against those of their professors and to observe at close range those who have committed their lives to academic careers.

**Trinity College of Arts and Sciences.** The undergraduate liberal arts student at Duke University has many options in curricular and cocurricular programs and in residential life. The curricular offerings, the educational facilities, and the University faculty of arts and sciences provide students with an opportunity for the development of special interests and talents. The cocurricular programs and activities in the residence halls reinforce the academic curriculum and provide various ways of bringing students and faculty together. Living-learning interest groups occupy some residences partially or totally. Fraternities and dormitories have joined in federations to sponsor academic and cocurricular programs.

**School of Engineering.** The undergraduate engineering program at Duke University is designed both for students who intend to become professional engineers and for those who desire a modern, general education based on the problems and the promises of a technological society. The environment in which students are educated is as important in shaping their future as their classroom experiences. In the Duke School of Engineering this environment has two major components: one is modern technology derived from the research and design activities of faculty and students in the School; the other is the liberal arts environment of the total University, with its humanitarian, social, and scientific emphases.

Engineering is not a homogeneous discipline; it requires many special talents. Some faculty members in the School of Engineering are designers; they are problem-oriented, concerned with teaching students how to solve problems—how to synthesize relevant information and ideas and apply them in a creative, feasible design. Other engineering faculty members function more typically as scientists; they are method-oriented, using the techniques of their discipline in their teaching and research to investigate various natural and man-made phenomena.

**School of Nursing.** The School of Nursing is committed to promoting human health and welfare by providing foundations for knowledgeable nursing services. The School aims to prepare its graduates to practice professional nursing in roles most appropriate to the level of their preparation and to provide its students with an educational background that will serve as a basis for advanced study in nursing and continued professional and personal growth.

Professional nursing practice involves interacting with human beings under stress, frequently over long periods of time; providing comfort and support in times of pain, anxiety, loneliness, and helplessness; using the nursing process to make judgments in establishing, implementing, maintaining, and/or modifying a



plan of health care; and knowing when and how to use existing and potential resources to help patients toward recovery and adjustment. Professional nursing practice involves sharing responsibility for the health and welfare of all those in the community; participating in programs designed to prevent illness and maintain health; coordinating professional and technical services in the best interest of patient care; and supervising, teaching, and directing those who give nursing care. Professional nursing practice requires constant evaluation; asks questions and seeks answers that will add to the body of nursing knowledge; and transmits and uses this knowledge, including research findings, to improve health service. Professional nursing practice requires knowledge and skill and provides opportunities for personal and professional fulfillment.

The faculty of the School of Nursing believes that the primary aim of nursing education is to provide an environment in which the student can develop self-discipline, intellectual curiosity, and the ability to think critically, and to acquire the knowledge and skills necessary for practice. The faculty also believes that learning is manifested by a change of behavior resulting from experience; that an atmosphere conducive to learning is one in which self-direction and creativity are encouraged; that the student who seeks admission to the School intends to practice professional nursing; and that the curriculum aids the student in realizing this intent and in stimulating the desire for continued professional growth.

**Policy of Nondiscrimination**

Duke University does not discriminate on the basis of race, color, national and ethnic origin, or sex, in the administration of educational policies, admission policies, financial aid, employment, or any other university program or activity. It admits qualified students of any race, color, and national and ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students.

# Degree Programs





## Degrees Offered

Duke University offers in Trinity College of Arts and Sciences the degrees of Bachelor of Arts and Bachelor of Science; in the School of Engineering, the degree of Bachelor of Science in Engineering; and in the School of Nursing, the degree of Bachelor of Science in Nursing. Within the four-year curriculum of each college or school, students have the major responsibility for designing and maintaining a course program appropriate to their background and goals. Students are assisted by faculty advisers, departmental directors of undergraduate studies, and academic deans.

Credit toward a degree is earned in units called semester-courses (s.c.), which ordinarily consist of three to four hours of instruction each week of the semester. Double-courses, half-courses, and quarter-courses are also recognized.

## Trinity College of Arts and Sciences

In the arts and sciences curriculum, either of two programs leads to the Bachelor of Arts or Bachelor of Science degree. The programs provide a variety of approaches to a liberal arts education, and in both Program I and Program II a student may study in the following divisions of learning:

*Humanities.* Art, Classical Studies (including Greek and Latin), Comparative Literature, Drama, English, Germanic Languages and Literature, Judaic Studies, Music, Philosophy, Religion, Romance Languages (including French, Italian, Portuguese, and Spanish), and Slavic Languages and Literatures (including Russian).\*

*Natural Sciences and Mathematics.* Botany, Chemistry, Computer Science, Genetics, Geology, Marine Sciences, Mathematics, Physics, and Zoology.

*Social Sciences.* Anthropology, Canadian Studies, Economics, Education, Health Education, History, Management Sciences (including Accounting), Physical Education, Political Science, Psychology, Public Policy Studies, and Sociology.\*

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\*Black Studies, Comparative Area Studies, Linguistics, and Medieval and Renaissance Studies include courses in both humanities and the social sciences.



## PROGRAM I

Program I provides a flexible approach to the Bachelor of Arts or Bachelor of Science degree by enabling students to choose, within broadly stated requirements, the particular subjects that best suit their intellectual interests and educational goals. The requirements, in brief, are listed below with page references to specific discussions of each.

1. The satisfactory completion of thirty-two semester-courses, including:
  - (a) at least sixteen at Duke (ordinarily including the work of the senior year);
  - (b) at least twelve at the advanced level;
  - (c) no more than four in military science; and
  - (d) no more than two with a grade of *D*.(See pages 20, 21, and 42.)
2. A distribution of courses among the three divisions of learning. (See page 17 and below.)
  - Division I: the courses of the major. (See pages 18, 19, and 20 and the section on Departmental Major following each department's course descriptions.)
  - Division II: at least four semester-courses, including two at the advanced level. (See pages 18 and 19.)
  - Division III: at least two semester-courses. (See page 19.)
3. Proficiency in English composition. (See page 19.)
4. Small-group learning experiences:
  - (a) before reaching junior status
    - (1) at least one full semester-course designated as a *seminar*, *tutorial*, or *independent study*, or
    - (2) a combination of two *preceptorials* or *discussion sections*.
  - (b) junior and senior years: at least two semester-course credits for *seminars*, *tutorials*, *independent study*, or a *thesis*.(See pages 19 and 20.)
5. Quality of work: all passing grades are expected. (See page 21 for minimum requirements.)

**Distribution of Courses.** The student in Program I completes at any time within eight semesters a number of semester-courses in each of the three divisions of learning (see page 17 and below). The courses in each division must be those in which the essential subject matter and substance of the discipline are presented, i.e., not skill courses. An interdepartmental course, an interdivisional course, a military science course, or a course from a professional school may not be used to satisfy distributional requirements unless it is cross-listed in an arts and sciences department. Courses offered in one division may not be used to satisfy distributional requirements in another division. Courses used to satisfy the requirements for small-group learning experiences may be used to satisfy distributional requirements. Courses taken on the pass/fail basis do not satisfy the distributional requirements unless offered only on a pass/fail basis. A student must complete a certain number of courses, excluding skill courses, in each of the three divisions as follows:

*First Division.* The division of the major (or concentration) is called the first division. Each student must complete requirements for a major (concentration) in a single discipline or in an interdisciplinary program. Thereby the requirement for the first division will automatically be satisfied. (See page 43.)

*Second Division.* Students must pass at least four semester-courses in a sec-



and division of their own choice. At least two of the four courses must be at the advanced level. (See page 20 regarding advanced work.)

*Third Division.* Students must pass at least two semester-courses in the third division.

**Courses That Do Not Satisfy Distributional Requirements of Program I\***

Art	53-54, 56, 119
Chinese	131, 132, 133, 134
Classical Studies	Greek 1-2
	Latin 1-2
Drama	101, 102, 103, 105
Education	105, 106, 107, 108, 151, 152, 161, 162, 195S, 196
English	1, 10, 50, 65S, 66S, 101S, 103S, 105S, 106S, 110, 120, 130
German	1-2, 63, 105, 181, 182
Health Education	134
Physical Education	4, 6, 11, 12, 14, 15, 16, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 37, 38, 39, 40, 41, 42, 43, 45, 46, 48, 50, 51, 52, 53, 60, 61, 62, 63, 65, 67, 68, 69, 70, 102, 103, 105, 106, 117, 132, 163, 164, 170, 171, 172, and 173
Hindi-Urdu	181, 182, 183, 184
Japanese	151, 152, 153, 154
Mathematics	19
Music	7-8, 65, 97, 107-108, 151, 152, Applied Music (except for tutorials)
Psychology	117
Religion	115-116, 139
Romance Languages	French 1-2, 63, 74, 76, 100, 150T, 181
	Italian 1-2, 63, 74, 100
	Portuguese 181
	Spanish 1-2, 63, 74, 76, 100, 105, 150T, 181
Russian	1-2, 63-64
Swahili	101, 102

\*In addition, certain other courses do not satisfy distributional requirements. (See page 18.)

**Proficiency in English Composition.** Each student is required to demonstrate ability to write effective English prose either by presenting a score of 700 or higher on the College Entrance Examination Board (CEEB) English Composition Achievement Test, or by passing a course in English composition, usually in the first semester of enrollment.

**Proficiency in Foreign Language.** Certain departments recommend or require foreign language proficiency for their majors. Candidates for the B.S. degree may be required by their major departments to be proficient in a particular foreign language. (See pages 37 and 38.)

**Small-Group Learning Experiences.** By supplementing the classroom and lecture methods of instruction, small-group learning experiences assure the student opportunities to engage in discussion, develop skills, refine judgment, and defend ideas when challenged. A *seminar* (ordinarily indicated by the suffix S) is an independent course of twelve to fifteen (exceptionally to twenty) students who, together with an instructor, engage in disciplined discussion. The number of meeting hours per semester is the same as for regular courses of equivalent credit. Instructors are encouraged as a minimum to hold, at mid-semester, individual conferences between the professor and each student in the course and to present, at the end of the semester, to each student a written evaluation of the student's work. A *discussion section* (D) is a group of approximately ten students and an instructor, in which discussion is the paramount characteristic; it is an integral part of a regular course in which every member of the class is enrolled. A *preceptorial* (P) is a group of usually no more than twelve students and an instructor in which discussion is

the primary component. It is an additional and optional unit attached to a regular course involving one extra meeting per week. No additional course credit is given for a preceptorial. A *tutorial (T)* is a group of one to five students and an instructor meeting for discussion which is independent of any other course. For *independent study* students pursue their own interests in reading, research, or writing, but are counseled by an instructor. See page 42 for procedures for enrolling in independent study. The requirements for small-group learning experiences are listed on page 19.

**Major (Concentration).** Although students in Program I are required to achieve breadth of intellectual experience by taking courses in each of the three divisions of learning, they are also expected to acquire some mastery of a particular discipline or interdisciplinary area. Each student will, therefore, complete a departmental major, an interdisciplinary major, or an interdepartmental concentration. (See page 43 for procedures for declaring the major or concentration.)

**Departmental Major.** A student must pass a number of courses within a department, as specified by that department, as well as courses in other departments which may be necessary or helpful for effective performance in the major. These requirements are set forth in the section following each department's course descriptions. A major consists of at least five courses beyond the introductory or basic prerequisite level in one department, but may not include more than eight semester-courses for the A.B. degree or more than ten semester-courses for the B.S. degree. The student may elect a more intensive major program. A student who completes requirements for the major in two departments may have both majors recorded on the official record. Foreign language departments may begin their major after the elementary and intermediate courses.

**Interdisciplinary Major.** A student may satisfy the requirement by completing work prescribed for a major in an approved program. These programs include Black Studies; Comparative Area Studies: Africa, Asia, Latin America; Comparative Literature; Genetics; and Medieval and Renaissance Studies.

**Interdepartmental Concentration.** A student may pursue an interdepartmental major program designed by the student and advisers as an alternate means of satisfying the major requirement. An interdepartmental concentration consists of at least three courses beyond the introductory level in each of two or more departments. (See page 43 for procedures for planning an interdepartmental concentration.)

**Advanced Courses.** Of the thirty-two courses required for graduation, at least twelve must be at the advanced level, i.e., 100- and 200-series.

**Military Science Courses.** No more than four courses in the military sciences may be counted among the thirty-two courses required for graduation. These courses are normally taken in the junior and senior years. Additional courses, although not counted toward graduation, do appear on a student's permanent academic record. Military science courses do not satisfy distributional requirements.

**Residence.** A residence period of four academic years (eight semesters) is the normal amount of time a student may take to earn either the Bachelor of Arts or the Bachelor of Science degree. This period may be extended for one or two semesters by a student's academic dean for legitimate reasons, if it seems probable that an extension will enable the student to complete all remaining requirements for graduation. A student will not be permitted residence of more than five academic years, that is, ten semesters, in order to be graduated.

For the minimum residence period, at least sixteen courses must be satisfactorily completed at Duke. If only sixteen courses are taken at Duke, they must include the courses of the final two semesters. A student with more than sixteen

courses at Duke may take two courses of the last year at another approved institution. A student who has completed six full semesters at Duke may take four courses in the last year at another approved institution. Courses taken elsewhere must be approved by the student's adviser and academic dean.

**Quality of Work (Continuation Requirements).** A student must achieve a satisfactory record of academic performance each semester and make satisfactory progress toward graduation each year to continue enrollment in college. A student who fails to meet the minimum requirements described below must leave college for at least two semesters. A summer session may be counted as a semester. The student may apply to the Associate Dean of Trinity College of Arts and Sciences for readmission. If, after readmission, the student again fails to meet continuation requirements, permanent dismissal will ensue.

Where continuation is in question, incomplete work in any course is considered a failure to achieve satisfactory performance in that course. Such courses must be completed in time for final grades to be submitted to the Registrar no later than the day preceding the first day of classes of the spring semester (for incompletes incurred in the fall semester), or June 10 in the summer (for incompletes incurred in the spring semester). In the case of incomplete work in the spring semester, this requirement applies whether or not the student plans to attend one or more terms of the summer session. The student, however, may not enroll in a summer term at Duke until the requirement of satisfactory performance each semester has been satisfied.

Any student excluded from the college under the provisions of these regulations may, on request, have the case reviewed by the Associate Dean of Trinity College of Arts and Sciences.

**Satisfactory Performance Each Semester.** To continue from one semester to a successive semester or summer session a student is expected to achieve passing grades in all courses. The student who does not pass all courses will be advised, but not required, to withdraw in any of the following circumstances:

- 1. After the first semester of the freshman year, the student fails more than one course.
- 2. A freshman or transfer student fails more than two courses in the first semester.
- 3. The student was carrying fewer than four courses.

**Satisfactory Progress Toward Graduation.** Each year prior to the beginning of fall semester classes, a student must have made satisfactory progress toward fulfillment of curricular requirements to be eligible to continue in the College; i.e., a certain number of courses must have been passed *at Duke* according to the following schedule:

<i>Fall or Spring Semesters Completed at Duke</i>	<i>Minimum Number of Semester-Courses Passed at Duke</i>
2	6
3	10
4	14*
5	18
6	22
7	26
8	28

\*The requirement on small-group learning experiences for the freshman and sophomore years must also be fulfilled.

Courses in the arts and sciences taken in the summer terms *at Duke* may be used to meet this requirement. No more than two courses completed with *D* grades may be counted toward fulfilling the requirements.



## PROGRAM II

**Nature and Purpose.** Program II is an alternate approach leading to either the A.B. or the B.S. degree. This program offers the student who has an unusual interest or talent in a single field, or an unusual combination of interests or talents in several fields, an opportunity to plan and carry out a special curriculum adapted to these interests and needs. The student and a departmental Program II adviser design an individual plan of study for the whole, or the remainder, of the student's college career. They assess background, needs, and ambitions and evaluate the resources inside and outside the University as means of satisfying those ambitions. They consider what academic courses would be useful and also take into account that a full semester or year of independent study or work/study on or off campus, or a period of study abroad, might be appropriate. Each curriculum is tailored to the special interests and talents of the student for whom it is designed. Topics have included Appalachian Cultural Studies, Twentieth-Century Musical Composition and Conducting, Topics in Plant Physiology, and the Political Implications of Contemporary Christian Thought.

**Admission.** Students interested in Program II should confer with the directors of undergraduate studies in the departments closest to their interests. If the student seems eligible for Program II, the director or other adviser, or an interdepartmental committee, will counsel the student concerning the design of the curriculum. When an interdepartmental committee is needed, one department will bear administrative responsibility. The curriculum must be approved by the department and also by the Committee on Program II of the Undergraduate Faculty Council of Arts and Sciences. Upon endorsement by that committee, it becomes an obligation assumed by the student, although it may be modified later with the approval of the department and the Committee on Program II. A description of the plan is sent to the student's academic dean, and each semester the student's progress in achieving the plan is also reported.

Until formally accepted into Program II, a student should register for courses to satisfy the curricular requirements of Program I. Upon acceptance into Program II, a student is relieved of most, but not all, requirements expected of Program I students. Should Program II be dropped for any reason, the student assumes all requirements of Program I.

Usually, a student will be accepted into Program II only after being in residence at Duke for one or two semesters. However, a transfer student or freshman who desires to be admitted in the first semester at Duke is invited to write the Office of Undergraduate Admissions before matriculation, providing a statement of qualifications and plans as a prospective Program II student.

**General Requirements.** Apart from the requirements arising from the approved plan of work, a Program II student must satisfy certain general requirements: thirty-two semester-course credits for graduation; the regulations on military science courses (page 20); and residence (page 20), although the requirements relating to the last two semesters may be adjusted to suit the student's approved plan of work.

## UNDERGRADUATE-PROFESSIONAL COMBINATION PROGRAMS

The Bachelor of Science or Bachelor of Arts may be awarded to a student who successfully completes three years in an approved curriculum in arts and sciences at Duke and also completes the first year of study in the Duke School of Forestry and Environmental Studies, School of Law, Graduate School of Business Administration, or Medical School. After two years at Duke University and before transfer to a professional school, a student may apply for a combination undergraduate-



professional program through the appropriate academic dean. To be eligible for the combined program a student must complete successfully all baccalaureate requirements, except eight elective courses, and must be admitted to the professional school. An exception is made for the student majoring in management sciences and entering the Graduate School of Business Administration; such a student need not complete the major as an undergraduate. An eligible student thus registers as a first-year student in the professional school. Upon satisfactory completion in the professional school of the work of the first two semesters, or equivalent, the student will be awarded a baccalaureate degree.

## PREPARATION FOR GRADUATE AND PROFESSIONAL SCHOOLS

Students planning to enter a graduate or professional school should consult their academic deans and faculty advisers at the earliest opportunity. Since many graduate and professional schools require special tests for students seeking admission, information regarding requirements should also be obtained from the catalogues of the appropriate schools. The University Counseling Center will provide applications for the testing programs.

**Graduate Schools of Arts and Sciences.** As soon as practicable, students should ascertain the requirements of the graduate schools which they are considering and should consult an adviser in the field of the proposed advanced study. Most graduate schools have requirements in foreign languages, and candidates for the degree of Doctor of Philosophy may be required to pass reading examinations, usually in German and French.

**Graduate Schools of Engineering.** Students interested in graduate work in engineering should consult the Dean of the School of Engineering or the director of graduate studies in one of the engineering departments. Most engineering graduate schools require that a candidate have the equivalent of a Bachelor of Science in Engineering degree; however, students in the natural and social sciences may obtain conditional admission if they have a sufficient background in mathematics.

**Graduate Schools of Nursing.** Students interested in entering either graduate or post-baccalaureate programs in nursing should consult their faculty advisers, the Director of Academic Programs, or the Dean of the School of Nursing.

**Graduate Schools of Business Administration.** Students seeking advice concerning preparation for graduate school in business administration may consult the Department of Management Sciences or the adviser for graduate business programs in Trinity College. Many graduate programs in business administration are designed specifically for students with little or no undergraduate work in business. Some schools require at least one year of calculus for admission. Additional courses in mathematics can be helpful, especially linear algebra, probability, statistics, and advanced calculus. Other areas which can be of special value are philosophy of science and formal logic, one or more of the behavioral sciences, economics, the physical sciences, and engineering.

**Medical and Dental Schools.** Students planning to enter schools of medicine, dentistry, or veterinary medicine can prepare for admission by completing any of the regular departmental majors in Program I or by completing Program II, and by taking those courses required by the professional schools of their choice. Virtually all medical schools and most schools of dentistry and veterinary medicine require the same basic group of college premedical courses—a year of biology, a year each of inorganic and organic chemistry, and a year of general physics. In addition, many schools require a year of English and a few require a foreign language. About a third of all medical schools now require a year of calculus and some suggest courses in statistics. For a complete listing of these and other requirements set by

each medical school, see *Medical School Admission Requirements*, published annually by the Association of American Medical Colleges. Current copies, as well as information concerning careers in dentistry, veterinary medicine, osteopathic medicine, and many allied health professions, are available in the office of the Adviser for the Health Professions. Students should discuss their programs of study with their major advisers, academic deans, and with the Adviser for the Health Professions.

**Law Schools.** Students who plan to prepare for law school should seek diversity in their undergraduate course programs and specialize in one or more areas. They may choose virtually any field for their major work. Although no specific courses are required, prelaw students have often chosen from the following courses: Management Sciences 90; Economics 51, 52; English 55, 56; History 21, 22, 91, 92, 105, 106; Philosophy 41 and 48; Political Science 91; Sociology 91.

For a fuller discussion of undergraduate preparation for the study of law, students should refer to the *Bulletin of the School of Law* or consult with the prelaw adviser in the College.

**Theological Schools and Religious Work.** Students contemplating theological study should correspond at the earliest opportunity with the appropriate schools and with the authorities of their churches to learn how to prepare for the specific programs they expect to enter. Probably, they will find that they should consider the following subjects: English language and literature; history, including non-Western cultures as well as European and American; philosophy, particularly its history and its methods; natural sciences, both the physical and the life sciences; psychology, sociology, and anthropology; the fine arts and music; Biblical and modern languages; religion, both in the Judaeo-Christian and in the Near and Far Eastern traditions. Some seminaries require Greek or Hebrew for admission. It is the understanding gained in these fields rather than the total number of credits or semester hours earned which is significant.

## The School of Engineering

Duke University offers in the School of Engineering programs of study which lead to the degree of Bachelor of Science in Engineering (B.S.E.) with majors in the



Departments of Biomedical, Civil, and Electrical Engineering, and the Department of Mechanical Engineering and Materials Science. Special programs of study in interdisciplinary fields (see page 30) leading to the B.S.E. degree may be arranged with approval of the engineering faculty. The four curricula in the engineering departments are accredited by the Engineers' Council for Professional Development.

For graduation with a Bachelor of Science in Engineering degree, a student must complete successfully a minimum of thirty-two semester-courses. These thirty-two semester-courses must include the following:

**General Requirements**

English.....	1 s.c.	This requirement is met by completing English 1.
Mathematics.....	4 s.c.	This requirement is met by completing Mathematics 31*, 32*, 103, and 104 or 111.
Natural Science .....	3 s.c.	This requirement is met by completing Chemistry 11 and Physics 51 and 52.
Social Sciences and Humanities .....	4 s.c.	This requirement is met by completion of four courses from at least two departments in the humanities and social sciences. This program of courses should reflect a rationale or fulfill an objective appropriate to the engineering profession. Courses selected must be those which present essential subject matter and substance of the discipline; for example, no introductory skill courses may be used to satisfy this requirement. Likewise, courses devoted primarily to subjects such as accounting, industrial management, finance, personnel administration, introductory language, and ROTC normally do not fulfill this objective regardless of their general value in the total engineering curriculum. House courses may not be used to satisfy this requirement.
Engineering and Applied Sciences.....	4 s.c.	This requirement is met by completion of at least one course from each of four of the following six areas; electrical science, information and computer science, mechanics (solid and fluid), systems analysis, and thermal science and transfer processes. See departmental requirements, which follow, for any specific courses to be included.
Digital Computation .....		Students are expected to have acquired digital-computer programming capability before their sophomore year. The programming capability may be satisfied by prior experience or by passing Engineering 51 or Computer Science 51.

**Departmental Requirements**

Departmental Specifications.....	16 s.c.	The department administering the major field of study will specify this requirement. In general, it will consist of both required courses and electives to be planned in consultation with the departmental adviser. See the individual departmental requirements, which follow.
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†Total Minimum  
Requirement.....32 s.c.

\*Mathematics 33 and 34 are acceptable in lieu of Mathematics 31 and 32.

†A maximum of two semester-courses of junior- or senior-level air science or naval science course work may be counted in satisfying the minimum requirements of thirty-two semester-courses for a baccalaureate degree in engineering. These courses must be included in the sixteen semester-courses listed under departmental requirements. All other courses completed in air science or naval science are taken in addition to the minimum program.



## Biomedical Engineering Departmental Requirements

All general requirements and departmental requirements are incorporated in the following sequence, only one of several possible sequences. The student is encouraged to choose electives and select a sequence which develops broad intellectual interests.

### Freshmen year

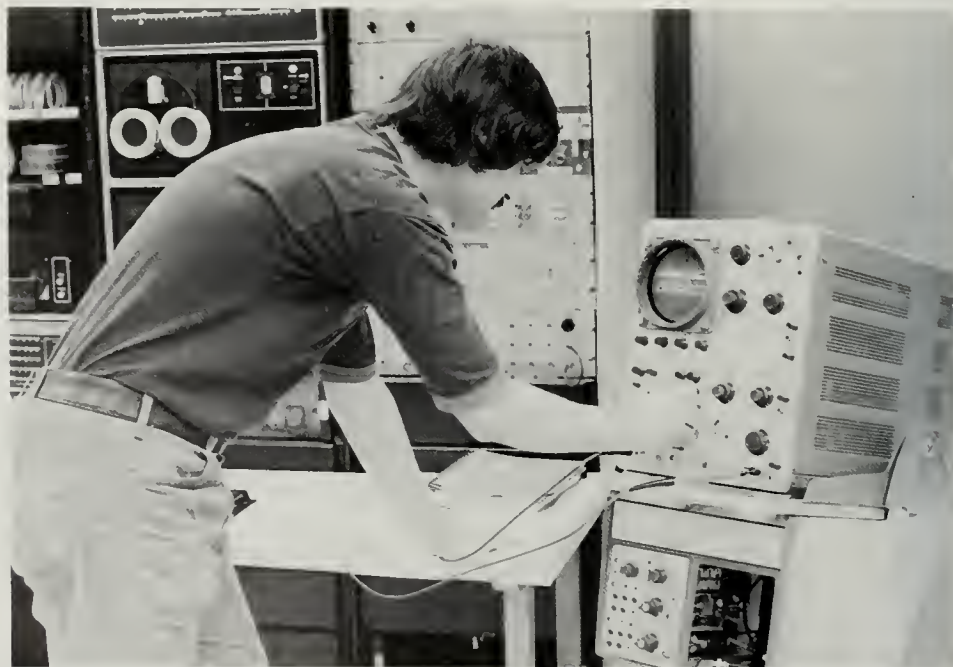
First Semester	Courses	Second Semester	Courses
Chemistry 11 .....	1	Chemistry 12 .....	1
English 1 .....	1	Elective .....	1
Mathematics 31 .....	1	Mathematics 32 .....	1
Engineering 51 .....	1	Social Science or Humanities Elective .....	1
	4		4

### Sophomore Year

First Semester	Courses	Second Semester	Courses
Physics 51 .....	1	Physics 52 .....	1
Biomedical Engineering 111 .....	1	Biomedical Engineering 131 .....	1
Mathematics 103 .....	1	Electrical Engineering 63 .....	1
Social Science or Humanities Elective .....	1	Mathematics 104 .....	1
	4		4

### Junior Year

First Semester	Courses	Second Semester	Courses
Biomedical Engineering 163 .....	1	Biomedical Engineering 164 .....	1
Biomedical Engineering 132 .....	1	Biomedical Engineering 125 .....	1
Engineering 135 .....	1	Elective .....	1
Elective .....	1	Biology Elective .....	1
	4		4





## Senior Year

First Semester	Courses	Second Semester	Courses
Biomedical Engineering Elective.....	1	Biomedical Engineering Elective.....	1
Biomedical Engineering 101 .....	1	Elective .....	1
Approved Elective.....	1	Elective .....	1
Social Science or Humanities Elective .....	1	Social Science or Humanities Elective.....	1
	—		—
	4		4

## Civil Engineering Departmental Requirements

The general requirements and the departmental requirements are all incorporated in the following typical program.

### Freshman Year

First Semester	Courses	Second Semester	Courses
Chemistry 11 .....	1	Civil Engineering 16.....	½
English 1 .....	1	Engineering 11 .....	½
Mathematics 31.....	1	Physics 51 .....	1
Engineering 51 .....	1	Mathematics 32.....	1
	—	†Approved Elective.....	1
	4		—
			4

### Sophomore Year

First Semester	Courses	Second Semester	Courses
Engineering 75 .....	1	Engineering 83 .....	1
Mathematics 103.....	1	Engineering 123 .....	1
Physics 52 .....	1	Mathematics 104 or 111.....	1
†Approved Elective.....	1	†Approved Elective.....	1
	—		—
	4		4

### Junior Year

First Semester	Courses	Second Semester	Courses
Civil Engineering 131 .....	1	Civil Engineering 123 .....	1
Engineering 145 .....	1	†Civil Engineering 133 .....	1
*Engineering Science Elective.....	1	Civil Engineering 139 .....	1
†Approved Elective.....	1	†Approved Elective.....	1
	—		—
	4		4

### Senior Year

First Semester	Courses	Second Semester	Courses
Civil Engineering 124.....	1	Civil Engineering 116 .....	1
†Civil Engineering 134 .....	1	†Approved Elective.....	1
†Approved Elective.....	1	†Approved Elective.....	1
†Approved Elective.....	1	†Approved Elective.....	1
	—		—
	4		4

\*Electrical Engineering 43, Engineering 72, or Engineering 101.

†Part of a program of elective courses planned with departmental approval to suit the interests and abilities of the individual student. In addition to satisfying the social science-humanities requirement of the School of Engineering, the program must include a minimum of one elective course in natural science. The program should also include a minimum of three *emphasis electives* which are designed to reinforce the student's major area of study. One emphasis elective must be a civil engineering course.

†Civil Engineering 133 or 134 may be replaced by an approved Civil Engineering design elective.

## Electrical Engineering Departmental Requirements

The general requirements and the departmental requirements are all incorporated in the following typical program. This program is presented as a guide to assist students in planning their four-year program and should not be viewed as an inflexible sequencing of courses.

### Freshman Year

First Semester	Courses	Second Semester	Courses
Mathematics 31.....	1	Mathematics 32.....	1
Chemistry 11.....	1	Physics 51.....	1
English 1.....	1	* Approved Elective.....	1
* Approved Elective.....	1	* Approved Elective.....	1
	—		—
	4		4

### Sophomore Year

First Semester	Courses	Second Semester	Courses
Electrical Engineering 63.....	1	Electrical Engineering 113.....	1
Mathematics 103.....	1	Mathematics 104.....	1
Physics 52.....	1	†Electrical Engineering.....	1
* Approved Elective.....	1	* Approved Elective.....	1
	—		—
	4		4

### Junior Year

First Semester	Courses	Second Semester	Courses
†Electrical Engineering.....	1	†Electrical Engineering.....	1
* Approved Elective.....	1	* Approved Elective.....	1
* Approved Elective.....	1	* Approved Elective.....	1
* Approved Elective.....	1	* Approved Elective.....	1
	—		—
	4		4

### Senior Year

First Semester	Courses	Second Semester	Courses
†Electrical Engineering.....	1	†Electrical Engineering.....	1
* Approved Elective.....	1	* Approved Elective.....	1
* Approved Elective.....	1	* Approved Elective.....	1
* Approved Elective.....	1	* Approved Elective.....	1
	—		—
	4		4

\*Part of a program of elective courses planned with departmental approval to suit the interests and abilities of the individual student. These approved electives must include six social science-humanities courses; one natural science course; one mathematics course beyond Mathematics 104; and five courses in engineering science, physical science, computer science, or mathematics (at least one of these five must be from the School of Engineering, and at least one from two of the following areas: information and computer science, materials science, mechanics, and thermal science). The remaining four approved electives may be any courses in the University offered for academic credit.

†These five courses in electrical engineering must be at the 100-level or above.

All Electrical Engineering students are requested to supplement the regular departmental requirements by choosing one of the following options:

Option 1. The student selects as many electives as possible from one of the major departmental areas:

*Electronics:* EE 42, 43, 103, 143, 157, 161, 164, 185, 186, 196, 199, 224, 225, 227.

*Computers and Information Processing:* EE 42, 157, 161, 185, 186, 203, 205, 206, 208, 224, 241, 251.

*Electromagnetics and Solid State:* EE 43, 143, 164, 196, 211, 212, 213, 215, 217, 271, 272.

*Communications and Control Systems:* EE 103, 143, 157, 161, 185, 186, 199, 203, 204, 205, 206, 222, 224, 225, 241, 251.

Option 2. The student plans a program of study with an adviser which will achieve a definite academic goal. This option may include taking a second major in another department or completing the requirements to enter another professional school (e.g., business, law, medicine).



## Mechanical Engineering and Materials Science Departmental Requirements

The general requirements and departmental requirements are all incorporated in the following typical program.

### Freshman Year

First Semester	Courses	Second Semester	Courses
Chemistry 11 .....	1	*Engineering Science Elective.....	1
Engineering 51 .....	1	Mathematics 32.....	1
English 1 .....	1	Physics 51 .....	1
Mathematics 31.....	1	†Approved Elective.....	1
	—		—
	4		4

### Sophomore Year

First Semester	Courses	Second Semester	Courses
*Engineering Science Elective.....	1	*Engineering Science Elective.....	1
Mathematics 103.....	1	*Engineering Science Elective.....	1
Physics 52 .....	1	Mathematics 111.....	1
†Approved Elective.....	1	†Approved Elective.....	1
	—		—
	4		4

### Junior Year

First Semester	Courses	Second Semester	Courses
Mechanical Engineering 115.....	1	Mechanical Engineering 136.....	1
Mechanical Engineering 123.....	1	Mechanical Engineering 150.....	1
Mechanical Engineering 126.....	1	†Approved Elective.....	1
†Approved Elective.....	1	†Approved Elective.....	1
	—		—
	4		4

### Senior Year

First Semester	Courses	Second Semester	Courses
Mechanical Engineering 141.....	1	‡Advanced Technical Elective .....	1
‡Advanced Technical Elective .....	1	‡Advanced Technical Elective .....	1
‡Advanced Technical Elective .....	1	†Approved Technical Elective.....	1
†Approved Elective.....	1	†Approved Technical Elective.....	1
	—		—
	4		4

\*The four courses in engineering science must be Engineering 72, 75, 83, and 101.

†Part of a program of elective courses planned with departmental approval to suit the interests and abilities of the individual student. These approved electives must include five social science-humanities courses and one course in natural science.

‡The advanced technical electives should be chosen to emphasize a professional objective in the curriculum.

The major requirements are included in the minimum total of thirty-two courses listed under general requirements and departmental requirements. Specific courses which must be included are Engineering 72, 75, 83, and 101; Mechanical Engineering 115, 123, 126, 136, 141, and 150.

**Double Major.** If an engineering student completes simultaneously the requirements for a departmental major in arts and sciences and the requirements for a B.S.E. degree, or satisfies simultaneously the requirements for two engineering majors, the official record will indicate this fact. However, the director of undergraduate studies for the second major must certify that the departmental major re-



quirements have been met. The student must initiate the procedure, either through the Dean of the School of Engineering or through the director of undergraduate studies in the second department. The completion of the requirements for the major in this department must be confirmed no later than the time of registration for the final semester. Courses which are common to both majors shall be counted toward satisfying the requirements of both majors.

**Interdisciplinary Programs in Engineering.** This major parallels the majors in biomedical, civil, and electrical engineering, and mechanical engineering and materials science. It provides for special programs of study in interdisciplinary fields, such as energy conversion, engineering mechanics, materials science, ocean engineering, pollution control, systems and controls, and urban engineering, leading to the B.S.E. degree, which may be arranged with approval of the engineering faculty. Any student, in consultation with the adviser or another faculty member, may propose a unique combination of courses designed to meet particular career objectives. The proposal should be submitted to the Engineering Faculty Council, through the Dean of the School of Engineering, for approval; it may be submitted as early as the second semester of the freshman year and must be submitted before the beginning of the senior year. The proposal should include the student's reasons for pursuing the suggested program of study, and it must show how the proposed courses satisfy the following requirements:

1. The proposed program of study meets the general requirements for the B.S.E. degree but cannot be accommodated by the approved departmental requirements in biomedical, civil, or electrical engineering, or mechanical engineering and materials science.

2. A program of at least eight engineering courses is included to provide depth in the chosen interdisciplinary area of study.

3. A program of at least five courses, in addition to the fifteen courses listed under general requirements, is included to provide breadth in technical areas (engineering, natural science, and mathematics).

4. The remaining courses, which are treated as electives, require the approval of the student's adviser.

Each student enrolled in an approved interdisciplinary program will be assigned to the appropriate engineering department for administrative purposes.

**Program in Engineering and Public Policy.** Engineering students may pursue a program of study leading to the degree of Bachelor of Science in Engineering, with a major in one of the five engineering fields of study and a second major in public policy studies. The program is sponsored by the School of Engineering and the Institute of Policy Sciences and Public Affairs. To qualify for a degree with this second major, a student must satisfy the series of courses, which may be characterized as electives within the engineering curriculum, that meet the requirements for the major in public policy studies. These requirements are a modified parallel of the requirements of the major in public policy studies as described on page 217.

**Residence Requirements.** At least sixteen semester-courses must be completed satisfactorily at Duke. This must include the work of the final two semesters, with the following exceptions: the student who has completed more than four full semesters of work at Duke may take the last two courses elsewhere; others may take the last course elsewhere. The courses taken elsewhere must be approved by the student's major adviser and academic dean.

**Pass/Fail Grading Option.** With the consent of the instructor and the faculty adviser, an engineering student may choose to be graded on a pass/fail basis on up to four unrestricted electives or social sciences-humanities electives within the thirty-two course program. A student may take no more than one course on a pass/fail basis each semester.

**Continuation Requirements.** A student must achieve a satisfactory record of academic performance each semester and make satisfactory progress toward graduation to remain enrolled in the University.

A student must pass at least three courses in each semester, except for the first semester of the freshman year, in which at least two courses must be passed. A student who fails to meet this continuation requirement must leave the University for at least two semesters. A complete summer session may be counted as a semester. Following application for readmission, return must be approved by the Dean and the director of undergraduate studies in the student's major department. If the student thereafter fails to pass three courses in a semester, permanent dismissal from the University usually results. A student who enrolls in more than four courses in a given semester and fails two or more of them will not be permitted to enroll for more than four courses in the following semester without approval of the Dean. In addition, a student may be dismissed temporarily or permanently for failing to make satisfactory progress toward graduation, including satisfactory progress toward fulfillment of curricular requirements within ten semesters.

The term *satisfactory progress* shall be defined also by the following schedule:

1. To begin enrollment in the second year, a student must have passed 6 s.c. and earned *P*, *C-*, or better in 3 s.c.
2. To begin enrollment in the third year, a student must have passed 13 s.c. and earned *P*, *C-*, or better in 9 s.c.
3. To begin enrollment in the fourth year, a student must have passed 20 s.c. and earned *P*, *C-*, or better in the 16 s.c.
4. To begin enrollment in the fifth year, a student must have passed 27 s.c. and earned *P*, *C-*, or better in 23 s.c.

**Grade Requirement for Graduation.** Of the thirty-two semester-courses required for graduation, twenty-eight must be passed with grades of *C-* or better.

## The School of Nursing

The baccalaureate program is designed to produce a professional nurse who:

1. Comprehends and appreciates opportunities, responsibilities, and relationships in a dynamic environment.
2. Develops knowledge, comprehension, and skills essential to the process of nursing.
3. Develops knowledge and comprehension of a professional role within a social, biological, and cultural framework.
4. Develops a foundation for potential social sensitivity and the desire for continuous self-development and fulfillment.

The overall goal of the curriculum is to prepare students to assume responsibilities as professional nurses and well-educated individuals. The course of study with its flexible approach prepares practitioners to function as professionals in nursing services for individuals, families, and communities.

The curriculum provides a base for professional growth; the knowledge, skills, and appreciations characteristic of those with a liberal education; and a foundation for graduate study. Studies in the freshman and sophomore years are devoted primarily to the liberal arts and basic sciences. During these years, cocurricular activities are provided to introduce the students to nursing. The focus of the junior and senior years is the nursing major. Transfer students can be accommodated in a curriculum of this design.

The students are seen as aggressive, active participants in making decisions about their own learning needs and interests. They are enabled and encouraged to plan a program of study compatible with their backgrounds and interests, one

which will contribute to their personal and professional goals. With the guidance of academic advisers, students may elect courses and experiences which best serve their interests for concentration in an area of study or for exploration in several fields. Teaching techniques take into consideration the spontaneity, potential, and individuality of the student.

The distinctive features of the curriculum are:

1. Although every student acquires a base in the natural and social sciences and in the humanities, students may choose to develop a second major in any of these three areas.

2. The conceptual framework of the curriculum is the nursing process. Students augment, complement, and integrate social, biological, and psychological theories and experiences as they use the nursing process in the care of individuals in need of health care.

3. Through courses comprising the professional nursing component, opportunities are provided for the student to progress in uniting knowledge and decision-making with nursing action toward individuals, groups, and families whether they be hospitalized or in the community.

4. Nursing electives and independent study in the upper division permit students to pursue individual interests, to broaden their scope of nursing, and to gain a degree of proficiency in the type of initial professional practice in which they wish to engage after graduation.

5. The curriculum is oriented theoretically in the belief that students who learn to select facts and theories from relevant disciplines for application to nursing practice will be able to adapt readily to changing modalities of health care.

**Program of Study.** For graduation with a Bachelor of Science in Nursing degree, a minimum of thirty-two semester-courses must be completed successfully. The courses are divided into lower and upper divisions, with thirteen upper division courses in nursing required for the nursing major.





## Lower Division

Natural Science .....	2 s.c.	May select from chemistry, botany, zoology, physics, geology, computer science, marine biology or biology.*
Human Ecology .....	2 s.c.	Nursing 97, 98
Statistics .....	1 s.c.	Any introductory course offered by the School of Nursing or by the Departments of Mathematics, Psychology, or Economics.
Social Sciences .....	3 s.c.	One course must be in psychology and the other two may be: <ul style="list-style-type: none"> <li>a. one in psychology and one in sociology or anthropology</li> <li>b. two in sociology</li> <li>c. two in anthropology</li> <li>d. one in sociology and one in anthropology.</li> </ul>
Humanities .....	1 s.c.	No skill courses satisfy this requirement. (See page 19).
English Composition .....	1 s.c.	English 1 (See page 19.)
Electives.....	6 or 7 s.c.	

\*Students electing Biology 11 must enroll in Biology 12.

Students must satisfy the small-group learning experience requirements during the first two years, as outlined on page 18.

## Upper Division

Theoretic and Scientific Bases for Nursing Practice .....	2 s.c.
Development of Nursing Skills and Attitudes I .....	4 s.c.
Theoretic and Scientific Bases for Nursing Practice II.....	2 s.c.
Development of Nursing Skills and Attitudes .....	4 s.c.
Required Independent Study .....	1 s.c.
Electives (including optional independent study) .....	3 s.c.

A student desiring to complete requirements for a second major in a department of arts and sciences may do so and have both majors entered on the official record. (See page 43.)

**Continuation Requirements.** A student must achieve a satisfactory record of academic performance each semester and make satisfactory progress toward graduation. A student who fails to meet the requirements outlined below must leave the University for at least two semesters. A summer may be counted as a semester. Following a student's application for readmission, return must be approved by the Dean of the School of Nursing. A student who is readmitted after having withdrawn voluntarily or involuntarily for academic reasons must make no grade lower than C- during the first semester in order to continue in school.

**Satisfactory Performance Each Semester.** To remain in the School of Nursing, a student must not fail three or more courses in the first semester of the freshman year or fail two or more courses in any subsequent semester. An exception to this policy applies when a student fails a required nursing course worth two semester-courses.

**Satisfactory Progress Toward Graduation.** A student must pass in the approved nursing curriculum at Duke the following number of semester-courses (or



the equivalent in half-courses or double-courses) to continue from one academic year to a subsequent year. (Summer terms at *Duke* or other approved institutions may be used to meet this requirement.)

To begin enrollment in the	a student must have passed
second year	6 semester-courses
third year	14 semester-courses
fourth year	22 semester-courses
fifth year	28 semester-courses

Students are reminded that incomplete work in any course is counted as a failure to achieve satisfactory performance in that course. Such courses must be completed in time for final grades to be submitted to the Registrar no later than the day preceding the opening of the spring semester or June 15 in the summer. In the case of incomplete work in the spring semester, this requirement applies whether or not the student plans to attend one or more terms of summer session.

Students excluded from the School of Nursing under the provisions of this regulation may, upon request, have their cases reviewed by the Undergraduate Studies Committee of the School of Nursing.

A minimum of fourteen courses must be passed before a student can proceed to the upper division professional curriculum. Twelve of these courses must have been passed with a grade of C- or better. All lower division requirements must be met before entry to the upper division.

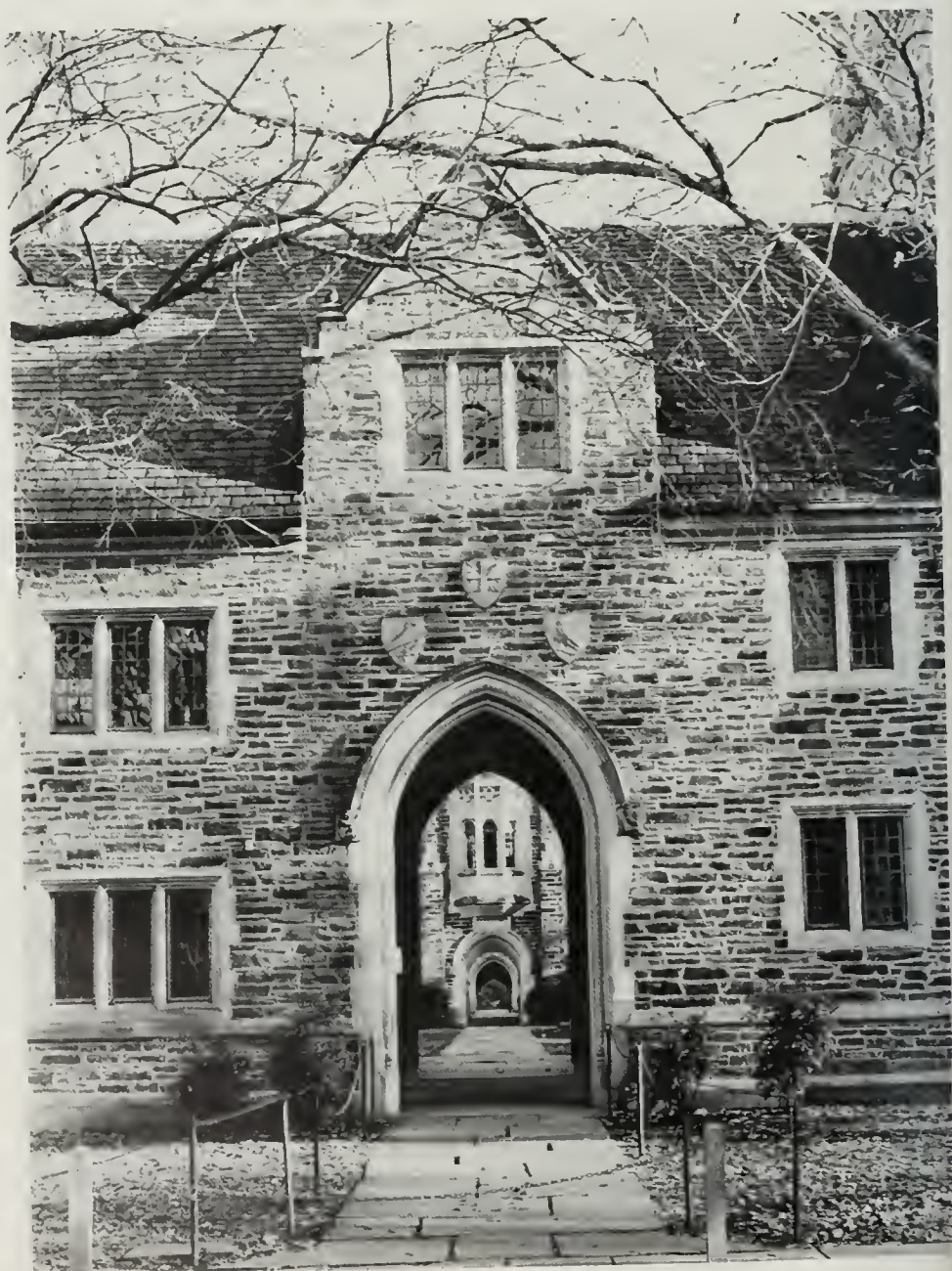
**Requirements for Degree.** To be graduated, a student must pass a total of thirty-two courses (or equivalent combination of courses, half-courses, and double-courses), including courses in the approved curriculum. Fourteen courses must be passed at the advanced level. Of the thirty-two courses required for graduation, no more than two courses with *D* grades will be accepted. Only required nursing courses with a grade of C- or better will be accepted toward graduation. It is required that for graduation the student have an overall C average or better in nursing courses and that all financial obligations to the University be satisfied.

**Residence Requirements.** The requirements for the normal and maximum periods of residence for students enrolled in the School of Nursing are the same as those in Trinity College of Arts and Sciences (see page 20). However, the minimum time that any student may spend in residence (full-time study) at *Duke* before receiving a Bachelor of Science in Nursing degree is one year, unless the student is a registered nurse completing the requirements for a B.S.N. For these students full-time or part-time study is possible.

**Transportation Required.** The use of facilities other than *Duke* and Veterans Administration Hospitals requires transportation. It is the responsibility of each nursing student to provide a means of transportation to and from the facilities selected for learning experiences in both the junior and senior years. Although a few agencies may be within bicycling distance, most are not.

**Accreditation.** In addition to the accreditation status accorded the University, the undergraduate program of the School of Nursing is accredited by the National League for Nursing and the North Carolina Board of Nursing.

# Academic Procedures and Information





## Advanced Placement

Scores on the tests discussed below and documented previous educational experience are the criteria used to determine a student's qualifications for certain advanced courses.

**CEEB Advanced Placement Program (APP) Examinations.** A score of 3, 4, or 5 on CEEB Advanced Placement Program Examinations is the basis for consideration for credit and placement in advanced courses in art, botany, chemistry, English,\* French, German, history, Latin, mathematics, music, physics, Spanish, and zoology. A student presenting such a score and desiring to continue in the same subject at Duke may request placement in an advanced course. In the case of French, German, Latin, and Spanish, APP scores of 3, 4, or 5 may result in placement in courses at the 100-level; approval of the director of undergraduate studies or supervisor of freshman instruction in the appropriate department is required before final placement is made. Credit may be granted for one or two courses in each subject area, with the approval of the academic department concerned. A student who has earned a score of 3 must complete a specified course in that subject with a grade of C or better before credit is awarded. Pass/fail grading is *not* an option for such courses. Ordinarily, the validating course must be completed by the end of the sophomore year.

**CEEB Achievement Tests.** Scores on CEEB Achievement Tests are the basic criteria for placement in French, German, Italian, Spanish, Latin, and mathematics, and students who present a score of 700 or higher on the CEEB English Composition Achievement Test are excused from the course in English composition required for graduation. Course credit, however, is not given for courses bypassed. The following tables will assist students in making reasonable course selections in the subjects indicated.

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\*These scores, although they qualify a student for advanced courses in literature, do not satisfy the requirement in composition. See the section on CEEB Achievement Tests.



French†		German		Italian	
CEEB Achievement Scores	Course Placement	CEEB Achievement Scores	Course Placement	CEEB Achievement Scores	Course Placement
200-390	French 1-2	200-360	German 1*	200-390	Italian 1-2
400-490	French 63	370-560	German 63	400-500	Italian 63
500-550	French 74, 76	570 plus	Third year†	510-550	Italian 74, 76
560 plus	French 100- level course			560 plus	Italian 100- level course

Spanish†		Latin		Mathematics	
CEEB Achievement Scores	Course Placement	CEEB Achievement Scores	Course Placement	CEEB Achievement Scores	Course Placement
200-450	Spanish 1-2	200-520	Latin 1*	Less than 530	Math. 19
460-550	Spanish 63	530-630	Latin 63	530-800	Math. 31
560-600	Spanish 74, 76	640 plus	Third year†	760-800	Math. 31X, upon request of the student
610 plus	Spanish 100- level course			600-800	Math. 33

\*The first year of a language may not be taken for credit by a student who has completed more than two years of that language in secondary school. In rare cases, an exception may be granted with permission of the director of undergraduate studies in the appropriate department.

†An exception may be granted in consultation with the director of undergraduate studies.

‡In these languages students are permitted to drop back one level without loss of credit (e.g., from 101 to 74 or from 74 to 63). No credit will be allowed for courses two levels below the achievement score (e.g., students with a score of 610 in French or Spanish could not receive credit for 63, but could for 74 or 76). In no case will credit be given for 1-2 to students with three or more years of high school French or Spanish.

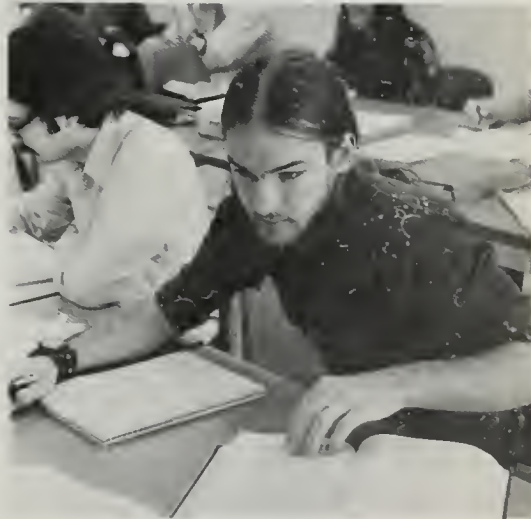
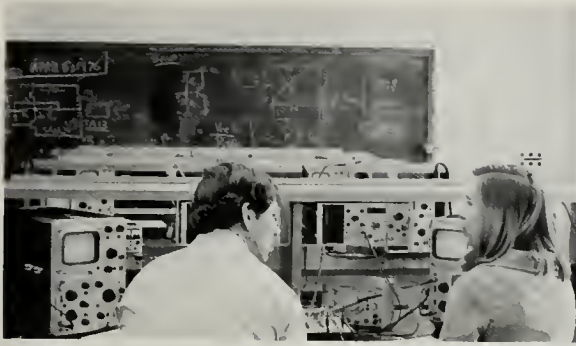
**CEEB College Placement Tests.** The CEEB Placement Tests in French, German, Italian, Latin, and Spanish should be taken during orientation by (1) those students who desire to continue in the language but have not taken the CEEB Achievement Test, and (2) those students who, having taken the CEEB Achievement Test, wish to challenge the score for the purpose of qualifying for a higher level language course. These tests are also administered at the end of each semester and at the close of the first term of the summer session for the convenience of those students who wish to demonstrate their foreign language proficiency by this means.

All freshmen who plan to take mathematics during their first semester at Duke, and who do not submit the CEEB SAT score or CEEB Achievement Test score in mathematics, must take the CEEB College Placement Test in mathematics during orientation. Students who have been placed in Mathematics 19 or 31 but believe that their background in mathematics justifies a higher course placement need not take the CEEB College Placement Test, but they should consult the Director of Undergraduate Studies in the Department of Mathematics.

Course credit is not given for courses bypassed on the basis of the placement tests.

**Placement in Russian.** Students who wish to continue in Russian at Duke should see the Director of Undergraduate Studies in the Department of Slavic Languages and Literature. In the case of Russian, neither CEEB Achievement Test





scores nor CEEB College Placement Test scores have been validated sufficiently to serve as criteria for placement. Therefore, the department offers an examination which is used in conjunction with other criteria for placing students at the appropriate course level.

**Reading Out of Introductory Courses.** Students demonstrating academic ability may be granted the option of "reading out" of an introductory or prerequisite course in order to allow them to advance at their own pace to upper-level work. No course credit may be earned by "reading out." Reading for a course and auditing are mutually exclusive procedures. Students must be recommended for the reading option by their academic deans, and their proposed programs of reading must be approved by the appropriate director of undergraduate studies. Students may be certified for advanced course work by passing a qualifying examination prepared by the department. When an advanced course is completed, an entry is made on

the permanent record that the qualifying examination was passed, but no course credit is awarded. Further information is available from academic deans.

**Placement in Nursing.** Registered nurses wishing to complete requirements for the Bachelor of Science in Nursing degree or students wishing to transfer nursing courses from other schools of nursing should see the Director of Academic Programs of the School of Nursing. Examinations and other criteria are used to determine appropriate placement in the approved curriculum.

**Transfer Credit.** Credit of up to sixteen semester-courses may be granted for course work satisfactorily completed by students transferring from other accredited, degree-granting institutions. Courses in which grades of less than C- have been earned are not accepted for transfer credit. The semester-course unit of credit awarded at Duke for satisfactorily completed courses cannot, of course, be directly equated with semester-hour or quarter-hour credits. Ordinarily, transfer students will not be awarded more than four semester-course credits for one semester's work unless they have satisfactorily completed more than the normal course load at the institutions from which they have transferred. All courses approved for transfer are listed on the student's permanent record at Duke, but grades earned are not recorded.

Courses taken at other institutions are evaluated by the University Registrar. Credit for courses in science, mathematics, and foreign language taken at a junior college may be evaluated by the Duke departments concerned; this is also true for some courses that have no Duke equivalents.

No credit is given for work completed by correspondence. Credit for not more than two semester-courses is allowed for extension courses.

## Advising

Students and their advisers confer when necessary, but they should confer before every registration period to review goals, plans for achieving them, and any problems encountered or anticipated. Before declaring a major, students confer with the freshman adviser, freshman dean, or the academic dean in the division of their interests. Upon declaring a major, the student is assigned a departmental adviser. The academic dean for that division is also available for consultation. In the School of Nursing, the adviser's signature is necessary for registration and all course changes. Much good advising is informal and occurs in conversation with members of the faculty.

## Registration

Students are expected to register at specified times for each successive semester. Prior to registration each student receives special instructions and registration materials. Students prepare a course program and present it at an appointed time to their advisers for review. The approved schedule is then presented at registration. In the School of Nursing, the schedule must be signed by the adviser. Trinity College students who are eligible to be graduated in the following calendar year (May, September, or December) must complete and file with the College Recorder a diploma card before registering for the spring semester.

Students who expect to teach in elementary or secondary schools should consult an adviser in the Department of Education prior to each registration period in order to ensure that they are meeting requirements for certification (many states have unique requirements), and that they will have places reserved for them in the student teaching program.

Those who register late are subject to a \$25 fine. Students who fail to register

are withdrawn and must apply for readmission if they wish to return; they also forfeit their \$50 registration deposits unless they indicate at the time of registration their intention not to continue in the University the following semester.

**Semester Opening.** Students are expected to report to a designated office at the beginning of each semester to obtain a semester enrollment card. Students who are unable to do so should notify their academic deans of their late arrival. Failure to report, or to account beforehand for an absence, entails a loss of registration in courses. Official enrollment is required for admission to any class.

**Course Changes After Classes Begin.** During the drop/add period changes may be made in course schedules. Course changes initiated by the student may be made free of charge during the first five days of the semester. During the remainder of the drop/add period, each course change initiated by the student entails a fee of \$1.50 per change. Students are reminded that it is their responsibility to be certain that their course load conforms with the academic requirements.

In Trinity College of Arts and Sciences, students may drop and add courses during the first week of classes at their own discretion. During the second week of the drop/add period they may drop courses at their own discretion, but the signature of the appropriate instructor is required for adding a course. After the drop/add period no course may be added; and to withdraw from a course, students must obtain permission from their deans. Factors to be considered by the dean include health, necessary outside work, and, up to the time midterm grades are issued, a course overload. In addition, the instructor of the course from which the student withdraws must certify the student's standing in the course as satisfactory or as failing. In the former case a *WP* will be entered on the permanent record and in the latter, a *WF*. Course work discontinued without approval will ordinarily result in a grade of *F*.

Within the School of Engineering and the School of Nursing, the signature of the adviser is necessary for dropping or adding courses after classes begin. After the drop/add period no course may be added, and in order to withdraw from a course students must obtain permission from their academic deans. Factors to be considered by the dean include health, necessary outside work, and, up to the time midterm grades are issued, a course overload. Until the last four weeks of classes in the semester, the instructor must certify the student's standing in the course as satisfactory or as failing. In the former case a *WP* will be entered on the permanent record and in the latter, a *WF*. During the last four weeks of classes in any semester, or the equivalent in the summer terms, a grade of *W* will be assigned if, in the judgment of the student's dean, compelling and extraordinary circumstances make it necessary for the student to drop the course; otherwise, the course must be continued to the end of the semester. A course discontinued without approval will result in a grade of *F*.

## Course Load and Eligibility for Courses

The normal and expected course load each semester is four semester-courses. To take fewer than four or more than five semester-courses in any semester, students must have the approval of their academic deans. No student, however, may take more than six courses in any semester. With the approval of their academic advisers, seniors in the School of Nursing who need fewer than eight semester-courses may take a three-course load either semester; seniors in Trinity College and the School of Engineering need permission of the appropriate academic deans.

"Self-pacing" during a given calendar year (two regular semesters plus three Duke summer terms) is also possible with the approval of the student's academic dean and faculty adviser (and in consultation with the Office of Undergraduate Fi-



nancial Aid, if the student is receiving monetary support from the University). A student may apply to take fewer than four courses for one or more semesters in a given calendar year after the freshman year. In every case, however, a student must meet the minimum requirements for semester-to-semester continuation at Duke, as well as those requirements that apply at the end of each calendar year. Advanced placement credits and summer work taken elsewhere are excluded when minimum requirements are considered under this plan.

The rules established by the Graduate School provide that juniors and well-qualified sophomores may enroll in a 200-level (senior-graduate) course if they have obtained written consent of the instructor, as well as that of the director of graduate studies in the department concerned. Within the School of Nursing, 200-level courses are open only to nursing seniors and nursing graduate students. Undergraduate students may not enroll in 300- or 400-level courses. No course may be repeated for credit or a grade if a passing grade has been earned previously, except where noted in the course description. A course previously passed, however, may be audited.

Seniors who, at the beginning of a semester, lack no more than three semester-courses toward the fulfillment of the requirements for the Bachelor of Arts or Bachelor of Science degree may enroll in graduate courses, for a maximum course load of five semester-courses. The permission of the Dean of the Graduate School is required, and admission to the Graduate School is necessary.

## Course Audit

With the written consent of the instructor, a full-time degree student is allowed to audit one or more courses in addition to the normal program. A part-time degree student may audit courses by payment of \$40 for each course audited. After the drop/add period in any semester, no student classified as an auditor in a particular course may take the course for credit, and no student taking a course for credit may be reclassified as an auditor. A student may not repeat for credit any course previously audited. Auditors submit no daily work, take no examinations, and receive no credit for courses.

## Independent Study

Independent study enables a student to pursue individual research and reading in a field of special interest under the supervision of a member of the faculty. (See page 20.) A student—with the approval of an adviser, the instructor, and the director of undergraduate studies in the instructor's department—may enroll in independent study for any semester at Duke. In the School of Nursing, students must have the approval of their academic advisers, faculty sponsors, and the coordinator for independent study.

## House Courses

House courses are initiated and organized by students within given residential units. They are generally, but not necessarily, interdisciplinary. If students are to earn credit for a course, it must be sponsored by a faculty member in the arts and sciences, acted upon by the department of that faculty member, and approved by the Committee on Courses of the Undergraduate Faculty Council of Arts and Sciences. In the School of Nursing, house courses are initiated and organized by students and faculty. Each house course must be approved by the Undergraduate Studies Committee and the School of Nursing faculty. House courses may carry



half-course credit. They do not fulfill distributional requirements, and not more than two semester-course credits earned in house courses may be counted toward the course requirements for graduation. Grades are submitted on a pass/fail basis. The Secretary of the Committee on Courses can provide further details for Trinity College courses.

## **Declaration of Major or Division in Trinity College of Arts and Sciences**

Each freshman must declare a division of interest (humanities, social sciences, or natural sciences), or a major, if desired, by registration in April of the freshman year, and all students must declare a major before the third week of the fourth semester. When a student declares a major, the second and third divisions must also be identified. The form for declaring a major or division is available from the academic deans; it is provided to freshmen with registration materials in the spring semester.

A student may declare an interdepartmental concentration after conferring with the directors of undergraduate studies of the departments involved, and they or other advisers assist the student in preparing a program of course work. The program must consist of at least three courses beyond the introductory level in each of the departments. An interdepartmental concentration must be planned early in the undergraduate career. One of the departments should be identified as primarily responsible for the student's advising. A copy of the plan for the program, with a descriptive title which will appear on the student's permanent record, should be presented, along with the written approval of the directors of undergraduate studies, to the appropriate academic dean. A student who declares an interdepartmental concentration must identify the second and third divisions and satisfy those requirements and all others for Program I.

A student may have a second major recorded on the permanent record. The second major should be declared in the office of the academic dean before the student registers for the final semester. A change of departmental major or interdepartmental concentration must also be registered with the academic dean. After declaring a major, a student is assigned an adviser in the department of the major and an academic dean in the division of concentration. Freshmen who declare a division rather than a major are advised by the academic dean in the division.

## **Class Attendance and Excused Absences**

Responsibility for class attendance rests with the individual student. Since regular and punctual class attendance is expected, the student must accept the consequences of failure to attend. Instructors may refer to the student's academic dean a student who is, in their opinion, absent excessively. As a rule, absences from required classes and tests are excused only for illnesses certified by a medical official of the University or for authorized representation of the University in out-of-town events. Officials in charge of groups representing the University are required to submit the names of students to be excused to the appropriate deans' offices forty-eight hours before absences are to begin.

## **Final Examinations and Excused Absences**

Unless departmental policy stipulates otherwise, the form of the final exercise is determined by the instructor. However, a final written examination may not ex-

ceed three hours in length and a final take-home examination may not require more than three hours in the actual writing. Take-home examinations are due at the regularly scheduled hour of an examination, based on the time period of the class. The times and places of final examinations are officially scheduled by the University Scheduling Committee, generally according to the day and hour of the regular course meeting. No changes may be made in the schedule without the approval of the committee.

If a student is absent from a final examination, an *X* is given instead of a final grade. An acceptable explanation for the absence must be presented to the appropriate academic dean within forty-eight hours after the scheduled time of the examination, or the *X* is converted to an *F*. If the absence is excused by a dean, the student arranges with the dean and the instructor for a make-up examination to be given at the earliest possible time. An *X* not cleared by the end of the semester following the examination not taken is converted to an *F*.

## Grading and Grade Requirements

Final grades on academic work are sent to students after the examinations at the end of the fall semester. At the close of the spring semester, grades are mailed to the student's home address. Mid-semester advisory grade reports for freshmen are issued each semester.

**Passing Grades.** Passing grades are *A*, exceptional; *B*, superior; *C*, satisfactory; *P*, passing (see pass/fail option below); and *D*, low pass. These grades may be modified by a plus or minus. A *Z* may be assigned for the satisfactory completion of the first semester of a two-course sequence, and the final grade for both courses is assigned at the end of the second course of the sequence.

Although the *D* grade represents low pass, not more than two courses passed with *D* grades may be counted among those required for year-to-year continuation or among the thirty-two courses required for graduation. Courses for which a *D* grade is earned, however, satisfy distributional requirements, as well as requirements in the major, in English composition, and in small-group experiences.

**Failing Grades.** A grade of *F* or *U* (see pass/fail option below) indicates that the student has failed the course. The grade is recorded on the student's record. If the student registers for the course again, a second entry of the course and the new grade earned are made on the record, but the first entry is not removed.

**Pass/Fail Option.** With the consent of the instructor and faculty adviser, a student who has declared a major may choose to be graded on a pass/fail basis in one elective, non-major course each semester or summer term. In addition, with the consent of the instructor, adviser, and director of undergraduate studies, a student may take for pass/fail credit courses in independent study or internship in any department including that of the major. Certain courses are offered only on a pass/fail basis. Unless a course is offered only on a pass/fail basis, a course passed under the pass/fail option does not satisfy distributional requirements.

After the drop/add period in any semester, no changes from pass/fail to regular status, or from regular to pass/fail status, are permitted in any course. A *P* may not be converted subsequently to a regular letter grade, and the course may not be retaken for credit.

**Grades When Absent from Final Examination.** (See Final Examination and Excused Absences on page 43.)

**Grades for Incomplete Work.** If, because of illness or other emergency, a student's work in a course is incomplete, an *I* may be assigned for the course instead of a final grade. Incomplete courses must be completed before the close of the suc-

ceeding semester; otherwise, the *I* is converted to an *F*. Seniors are expected to complete all courses before graduation. If a student whose work is incomplete is also absent from the final examination, an *X* is assigned for the course. For the purposes of determining whether a student satisfies continuation requirements, an *I* is counted as failing to achieve satisfactory performance in that course.

## Commencement

Graduation exercises are held once a year, in May, when degrees are conferred on, and diplomas are issued to, those who have completed degree requirements by the end of the spring semester. Those who complete the requirements by the end of the fall semester or by the end of a summer term receive diplomas dated December 30 or September 1, respectively. There is a delay of about one month in the mailing of September and December diplomas because diplomas cannot be issued until they are approved by the Academic Council and the Board of Trustees.

## Academic Honors

To determine eligibility for academic honors, only grades earned at Duke are used in calculating the average.

**Dean's List.** In recognition of superior academic achievement, freshmen, sophomores, and juniors who carry a normal academic load and earn a *B* average or higher in the two semesters of an academic year are placed on the Dean's List if the following additional requirements are met:

1. Grades other than *P* have been earned in six semester-courses.
2. No incomplete or failing grade has been received during the academic year.

**Class Honors.** Students in the freshman, sophomore, or junior class who carry a normal academic load and earn a *B+* average on all work for the year are eligible for Class Honors provided the following conditions are also met:

1. Grades other than *P* have been earned in six semester-courses.
2. No incomplete or failing grade has been received during the academic year.

**Graduation Honors.** Students who earn the following averages for all work taken at Duke are graduated with honors: *B* average, *cum laude*; *B+* average, *magna cum laude* and *A-* or above, *summa cum laude*.

**Graduation with Distinction.** Most of the academic departments have programs for graduation with distinction for students in Programs I and II and in all nursing and engineering programs. To be eligible for this honor, students in Programs I and II and in engineering programs must show promise of achieving, by the time of graduation, at least a *B* average in the major field. Departments or interdepartmental honors committees may invite a student at the end of the sophomore or junior year to enter the Graduation with Distinction Program. After participation in a seminar in the junior or senior year, and/or a directed course of reading, laboratory research, or other independent study, the student must present the results of individual research and study in a distinguished piece of writing. The student's achievement, including the paper, is assessed by a faculty committee, and if the student has at least a *B* average in the major field, the committee may recommend that the student be graduated with distinction in the major field. A student engaged in an interdisciplinary program must attain an overall *B* average for courses taken in the departmental area of concentration or special study. Achievement is assessed by an interdepartmental honors committee established by the di-



rectors of undergraduate studies in the departments concerned. Interested students should consult the appropriate directors of undergraduate studies.

In the School of Nursing, graduation with distinction allows the capable student to develop critical thinking, and to develop or expand knowledge in the study of a nursing problem with faculty guidance and with public recognition for demonstrated mastery. The student must have a *B+* average at the beginning of the senior year and at the end of the senior year to be eligible for graduation with distinction. Interested students should contact the coordinator for the honors program in the School of Nursing for graduation with distinction.

**Other Honors.** Elections to the freshman honorary societies, Ivy and Phi Eta Sigma, of students who earn a *B+* average, are made at the end of the first semester and also at the end of the freshman year. The requirements are the same as those for class honors.

Elections to the national honorary society, Phi Beta Kappa, are held in the fall and spring; seniors are elected at both times, and juniors are elected in the spring only. Additional elections, chiefly of transfer students and doctoral students, are held in the fall following the student's graduation or the awarding of the Ph.D. degree. Eligibility for election is determined not by the University, but by the local chapter of the Society, and is based on good character and superior academic achievement. Seniors are usually considered after the completion of six or seven semesters of work, or the equivalent. No fewer than four-fifths of the student's grades must have been awarded at Duke. Juniors are considered after the completion of five semesters of exceptionally meritorious work. The total number elected usually does not exceed 8 percent of the graduating class. Inquiries may be directed to the Secretary of Phi Beta Kappa, Box 4795, Duke Station, Durham, North Carolina 27706.

Election to the national nursing honorary society, Sigma Theta Tau, is made in the spring. Both juniors and seniors in the School of Nursing and outstanding members of the profession are elected at this time. Eligibility is determined on the basis of scholarship (students must have a *B* average), leadership, variety of outside activities, interest in nursing, and potential for excellence in the profession. Inquiries may be directed to Sigma Theta Tau, Duke University School of Nursing, Durham, North Carolina 27710.

Several prestigious fellowships for graduate study are awarded. Interested students should consult the academic dean in charge of fellowships.

## Prizes and Awards

The achievements of undergraduate students are recognized in various fields of activity. The following prizes suggest the range of recognition.

**The Robert E. Lee Prize.** This prize is the gift of the late Reverend A. W. Plyler, of the Class of 1892, and Mrs. Plyler. The sum of \$50 is awarded annually at Commencement to the person in the senior class of Trinity College of Arts and Sciences or the School of Engineering who, in character and conduct, scholarship, athletic achievement, and capacity for leadership, has personified most nearly the standards of the ideal student.

**Julia Dale Prize in Mathematics.** This is an annual prize of at least \$50. The winner is selected by the Department of Mathematics on the basis of excellence in mathematics. In some years first and second prizes are given.

**The Henry Schuman Music Prize.** A prize of \$100 is awarded annually to an undergraduate of Duke University for an original composition of chamber music or a distinguished paper in music history or analysis. The award is sponsored by Trinity College of Arts and Sciences and the Department of Music through a con-





tinuing gift from Dr. and Mrs. James H. Semans who named the prize after Henry Schuman, a life-long friend of the Semans and Trent families, a talented amateur violinist, and one who helped to build valued collections in the Duke Library.

**The Phi Lambda Upsilon Prize.** Phi Lambda Upsilon, the honorary chemical society, annually awards a prize of \$20 to the junior chemistry major (A.B. or B.S.) having the highest overall academic average. The recipient's name is inscribed on a plaque displayed in the Chemistry Library.

**The Chemistry Department Award.** This prize is awarded annually to an outstanding chemistry major, usually receiving a B.S. degree. The basis for selection is the student's independent research and interest in pursuing advanced work in chemistry. The prize is a one-year subscription to an appropriate journal.

**The Merck Index Award.** This prize is awarded annually, normally to one or two graduating chemistry majors intending to pursue a career in medicine. Selection, by a faculty committee, is based on scholastic excellence. The prize consists of a copy of the Merck Index.

**The James B. Rast Memorial Award in Comparative Anatomy.** The parents of James Brailsford Rast, a member of the Class of 1958 of Duke University, endowed this award in his memory. The award, consisting of the *Atlas of Descriptive Human Anatomy* by Sobotta and bearing the James B. Rast Memorial bookplate, is given annually to the student who demonstrates the greatest achievement in the study of comparative anatomy.

**The Winfred Quinton Holton Prize in Primary Education.** This prize was established in 1922 by gifts of Holland Holton, (Class of 1907), and Mrs. Lela Young Holton, (Class of 1907), in memory of their son, Winfred Quinton Holton, with the income to be used to provide a prize for investigative work in primary education. This prize of approximately \$175 may be made annually. Competition is open to Duke seniors and graduate students who are candidates for a degree in elementary education. A student who wishes to be considered for the prize must submit a paper to be judged by a faculty committee in the Department of Education. The student must have a faculty supervisor, and only scholarly papers which the student and faculty supervisor deem appropriate for publication should be submitted. Papers must be submitted by April 1 for consideration in a particular year.

**The Anne Flexner Memorial Award in Creative Writing.** This award has been established by the family and friends of Anne Flexner, who was graduated from Duke in 1945. It consists of \$200 (first prize), \$100 (second prize), and \$50 (third prize). The awards are given annually for the best pieces of creative writing submitted by Duke undergraduates. The competition is limited to short stories (7,500-word limit), one-act plays (7,500-word limit), poetry (100-line limit), and informal essays (5,000-word limit). Only one manuscript may be submitted by a candidate, and it must be delivered to the Department of English, Room 325 Allen Building, by March 15.

**The Anne Barbour Stow Memorial Award.** This award has been established by the family and friends of Anne Barbour Stow, who graduated from Duke in 1963 with a major in English. The stipend, approximately \$500, is awarded, usually during the senior year, to an undergraduate English major who best fulfills those qualities which the late Anne Stow represented.

**The David Taggart Clark Prize in Classical Studies.** This prize is awarded to the senior major in Greek, Latin, or classical studies who is judged to have written the best honors essay of the year.

**The William Senhauser Prize.** Given by the mother of William Senhauser in memory of her son, a member of the Class of 1942, who gave his life in the Pacific theater of war on August 4, 1944, this award is made annually to the student in Trinity College of Arts and Sciences or the School of Engineering who has made the greatest contribution to the University through participation and leadership in intramural sports. The winner of this prize is chosen by a committee appointed by the President of the University.

**The Roger Alan Opel Memorial Scholarship.** The grant of \$500 is awarded annually to a Duke student who will spend a year of undergraduate study at a British university. The student is selected on the basis of intellectual curiosity, academic ability, and financial need. The award was established by the parents of Roger Alan Opel, a senior at Duke University who was killed in November, 1971.

**The William T. Laprade Prize in History.** This prize is offered in honor of William T. Laprade, who was a member of the Department of History at Trinity College and Duke University from 1909 to 1953, and Chairman of the Department from 1938 to 1952. It is awarded to a senior who is being graduated with distinction and whose senior essay in history has been judged to be unusually meritorious.

**The Edward C. Horn Memorial Prize for Excellence in Zoology.** Given each year to the graduating zoology major who has shown, in the opinion of the zoology faculty, the highest level of academic achievement and promise, this prize is offered in memory of Professor Edward C. Horn. It is a tribute to his warm regard for students and faculty and his appreciation of scholarly excellence. The prize consists of books appropriate to the student's field of interest.

**The James H. Oliver Memorial Award.** This award was established in 1963 by

the family of James H. Oliver and is given to the student or students who have done the most to further the interest of music at Duke University. A prize of up to \$150 is awarded annually.

**Robert S. Rankin Political Science Award.** An annual award of \$100 is given to the most outstanding student in the field of American government and constitutional law. The funds are donated in memory of Professor Rankin by Judge Jerry B. Stone, A.B. (Class of 1944), J.D. (Class of 1948).

**N. Joseph Rahall Political Science Award.** An annual award of \$100, contributed by Mr. Rahall, A.B. (Class of 1935), is to be awarded for the best paper submitted by an undergraduate major in political science.

**The Karl E. Zener Award for Outstanding Performance of an Undergraduate Major in Psychology.** The Karl E. Zener Award will be given annually to an undergraduate psychology major at Duke University who has shown outstanding performance and scholarship. The award will be based on the student's total grade record, plus a paper submitted to the Award Committee. The award will consist of a monetary prize from the income of the fund and inclusion by name on a memorial plaque in the Sociology-Psychology Building.

**The Tau Beta Pi Prize.** This prize is awarded each year by the North Carolina Gamma Chapter of Tau Beta Pi, the engineering national honor society, to a sophomore student in engineering for outstanding scholastic achievement during the freshman year.

**The Walter J. Seeley Scholastic Award.** This award is presented annually by the Engineer's Student Government to that member of the graduating class of the School who has achieved the highest scholastic average in all subjects, and who has shown diligence in pursuit of an engineering education. The award was initiated to honor the spirit of academic excellence and professional diligence demonstrated by the late Dean Emeritus Walter J. Seeley. It is hoped that this award will serve as a symbol of the man and the ideals for which he stood. The name of the recipient is inscribed on a plaque displayed in the Engineering Building.

**The American Society of Civil Engineers Prize.** The prize is awarded annually by the North Carolina Chapter of the American Society of Civil Engineers to two outstanding civil engineering seniors, upon recommendation of the faculty of the Civil Engineering Department. The basis for selection is the student's scholastic record, contribution to the student chapter, and participation in other college activities and organizations. The prize consists of a Certificate of Award and the payment of one year's dues in the American Society of Civil Engineers.

**The George Sherrerd III Memorial Award in Electrical Engineering.** This award is presented annually to the senior in electrical engineering who, in the opinion of the electrical engineering faculty, has attained the highest level of scholastic achievement in all subjects and has rendered significant service to the School of Engineering and the University at large. The award was established in 1958 by the parents of George Sherrerd III, a graduate of the Class of 1955, to recognize outstanding undergraduate scholarship. Recipients receive a monetary award, and their names are inscribed on a plaque displayed in the Engineering Building.

**The Charles Ernest Seager Memorial Award.** This award recognizes outstanding achievement in the annual Student Prize Paper Contest of the Duke branch of the Institute of Electrical and Electronics Engineers or significant contributions to electrical engineering. The award, established in 1958 by the widow and friends of Charles Ernest Seager, a graduate of the Class of 1955, consists of inscribing the name of the contest winner on a plaque displayed in the Engineering Building.

**The Milmow Prize.** This prize is awarded annually to the students from North or South Carolina graduating in the Department of Electrical Engineering, who, in



the opinion of the faculty of that department, and, as shown by their grades, have made the most progress in electrical engineering during the last year in school. The prize consists of a Certificate of Award and one year's payment of dues in the Institute of Electrical and Electronics Engineers for the membership year in which the honoree is awarded the baccalaureate degree.

**The Raymond C. Gaugler Award in Materials Science and Engineering.** This award is presented annually to the senior who has made the most progress at Duke in developing competence in materials science or materials engineering. The basis for selection is the student's scholastic record, research or design projects completed at Duke, and interest in a materials-related career. The award has been established by Patricia S. Pearsall in memory of her grandfather, Raymond C. Gaugler, who was President of the American Cyanamid Company prior to his death in 1952.

**The American Society of Mechanical Engineers Award.** This award is presented annually to a senior in mechanical engineering for outstanding efforts and accomplishments in behalf of the American Society of Mechanical Engineers Student Section at Duke. The award consists of a Certificate of Recognition.

**The Theodore C. Heyward Award.** This award of \$250 is given annually to the graduating senior who has demonstrated a real interest and marked ability in the study of mechanical engineering. The recipient is selected by the student members of Pi Tau Sigma.

**Aaronson Scholarship Award.** Established by Dr. Pauline Gratz in memory of her husband, Sidney Aaronson, this award is presented annually to the graduating nursing student who, having been admitted to the Duke University School of Nursing as a freshman and having completed all requirements for the Bachelor of Science in Nursing degree at Duke University, holds the highest scholarship achievement in the graduating class on the basis of a cumulative quality point ratio. The award consists of a certificate of recognition and a cash award of \$100.

**The Moseley Award.** The Moseley Award of \$25 is given to the student in the senior class who holds the highest scholarship achievement in required nursing courses on the basis of cumulative grade point average.

**Outstanding Service Award.** The Outstanding Service Award is presented to the student who has demonstrated outstanding service to the School of Nursing or community.





## Enrollment for the Duke Summer Session

Duke undergraduates who plan to attend one or more terms of a Duke summer session, or who plan to take a course in independent study during the summer should register, if possible, in the spring at the same time they register for the fall semester. Enrollment after the spring registration period may be initiated in the office of the appropriate academic dean. Undergraduates in universities or colleges other than Duke University should apply directly to the Director of Summer Educational Programs, Duke University, Durham, North Carolina 27706.

Distinctive features of summer session instruction include various conferences, sponsored by several of the departments, and a program in marine biology offered at the Duke Marine Laboratory, Beaufort, North Carolina 28615. (See the *Bulletin of the Summer Session*.)

## Changes in Status

**Withdrawal and Readmission.** Students who wish to withdraw from the University must give official notification to their academic deans. For students withdrawing on their own initiative prior to the Thanksgiving recess in the fall semester or prior to April 15 in the spring semester, a *W* is assigned in lieu of a regular grade for each course. Thereafter, an *F* is recorded for each course unless withdrawal is caused by an emergency beyond the control of the student.

Applications for readmission are made to the appropriate school or college. Each application is reviewed by officers of the school or college to which the student applies, and a decision is made on the basis of the applicant's previous record at Duke, evidence of increasing maturity and discipline, and the degree of success attendant upon activities during the time away from Duke. Students who are readmitted usually cannot be housed on campus.

Applications for readmission must be completed by November 15 for enrollment in January, by April 1 for enrollment in the summer, and by July 1 for enrollment in September. For readmission to the School of Nursing, however, it is required that the readmission procedure be completed by February 1 for September enrollment and by November 1 for January enrollment.

**Leave of Absence.** An upperclassman in good standing may apply in writing to the appropriate academic dean to take a leave of absence for one or two semesters.

In order to receive a leave of absence, a student must apply by the end of the registration period for the semester immediately preceding the leave. If the leave is approved, the University will place those students in study abroad programs and on medical or financial leaves in the general housing lottery provided that the student submits the appropriate information to the Office of Student Affairs by the end of the course registration period of the semester immediately preceding the leave. Those students approved for personal leaves are not guaranteed on-campus housing but will be placed with top priority on the housing waiting list provided the same deadline stated above has been met. Unless an exception for an emergency is authorized by the students' academic deans, students applying after the course registration cited above will lose their priorities in University housing for the period following the leave.

Registration materials will be mailed to a student on leave, but final registration is, of course, contingent upon the students fulfilling the terms of the leave. Students failing to register during their leaves will be withdrawn from the University and will have to apply for readmission.

A student who undertakes independent study under Duke supervision and for Duke credit is not on leave of absence even if studying elsewhere. The student reg-

isters at Duke as a non-resident student and pays the appropriate fees or tuition at Duke. This also applies to Duke programs conducted away from the Durham campus.

**Transfer Between Duke University Schools.** A student in good standing may be considered for transfer from one Duke undergraduate school or college to another, upon written application and request for letter of recommendation from the academic dean. The review of requests to transfer involve consideration of a student's general academic standing, citizenship records, and relative standing in the group of students applying for transfer. The school or college to which transfer is sought will give academic counseling to a student as soon as intention to apply for transfer is known, although no commitment will be implied. Students wishing to transfer to the School of Nursing for the succeeding year must complete transfer proceedings by February 1; however, openings for transfer students are limited, and students are accepted only at the junior level. Students seeking transfer are advised to consult the Director of Academic Programs in Nursing as early as possible.

A student may apply to transfer at any time prior to, or after, receiving a baccalaureate degree. If admitted after having earned a baccalaureate degree, a student must undertake prescribed additional undergraduate work to qualify for a second baccalaureate degree.

**Full-Time and Part-Time Degree Status.** Ordinarily candidates for degrees are expected to enroll for a normal course load each semester. A student who needs to change from full-time status, however, or from part-time to full-time status, must confer with an academic dean. For special reasons approved by the dean, a full-time student, who is qualified to continue, may register as a part-time student for not more than two courses. Part-time students may not live in the residence halls.

**Resident and Nonresident Status.** Sophomores, juniors, and seniors who wish to live off-campus may apply to the Office of the Dean of Student Affairs or, if appropriate, to the Dean of Student Affairs of the School of Nursing. (See page 61.)

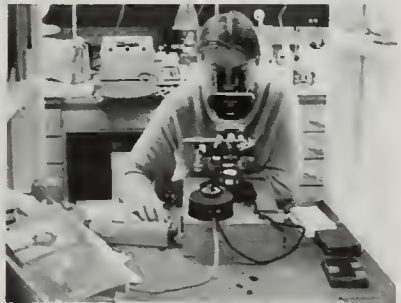
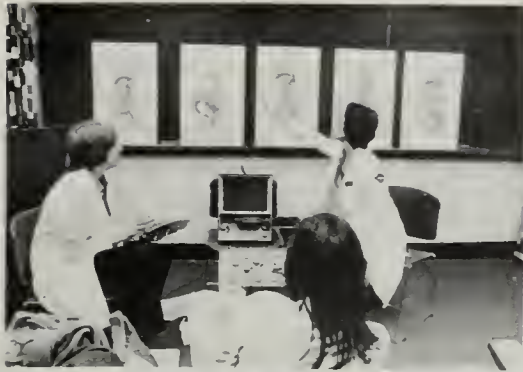
**Nondegree to Degree Status.** A nondegree student must apply to the Office of Undergraduate Admissions for admission to degree candidacy.

## Study Elsewhere

**Concurrent Enrollment.** A student enrolled at Duke may not enroll concurrently in any other school or college without special permission of the appropriate academic dean. (See, however, the statement regarding the reciprocal agreement with the University of North Carolina at Chapel Hill, North Carolina Central University in Durham, and North Carolina State University at Raleigh.)

**Limitation on Work Taken Elsewhere.** After matriculation as a full-time degree candidate in Trinity College of Arts and Sciences, a student may receive credit toward the B.S. or A.B. degree for a maximum of two courses taken at another institution, whether in the summer, while regularly enrolled at Duke, while withdrawn voluntarily from the College, or while on leave of absence (other than for an approved program of study abroad or an approved program at another institution in the United States). Ordinarily, no credit will be accepted for course work taken while a student is withdrawn involuntarily. For purposes of this regulation, advanced placement credit is considered as work taken at Duke, and the provision of the residency requirement which allows a student to take the final courses elsewhere remains in effect. (See page 20.)

**Summer Schools.** Approval forms for courses to be taken at institutions other than Duke may be obtained from the offices of the academic deans. Students wishing to transfer credit for proposed summer work at another accredited college



should present a summer catalogue of that college to the appropriate dean and director of undergraduate studies and obtain their approval prior to taking the courses.

**Study Abroad.** A Duke student may earn credit for up to eight semester-courses during an academic year for approved work completed at a foreign university or for an approved program abroad sponsored by Duke or by another American college or university. To earn the equivalent of four Duke credits each semester, a student who studies abroad will be expected to take a full course load as defined by the program or institution involved. Ordinarily, work to be considered for transfer credit must be done in the language in which courses are normally given at the institution attended. Duke, at present, offers several programs in cooperation with other universities. Students accepted may study at:

*Aix-en-Provence, France.* Courses are given in French language, art, philosophy, and literature. Completion of French 74, or equivalent, is required prior to departure. This program is administered through Vanderbilt University.

*Madrid, Spain.* Work is given in Spanish language, literature, art, music, and history for either the fall or spring. Completion of Spanish 74, or equivalent, is required prior to departure. This program is under the direct administration of Vanderbilt University.

*Rome, Italy.* As one of the participating members in the Intercollegiate Center for Classical Studies in Rome, Duke University nominates majors in classical studies for admission to a semester's work at the center, usually in the junior year. In-



struction is offered in Greek, Latin, ancient history, ancient art, and archeology. Some scholarship help is available.

*Munich and Freiburg, Germany.* Admission to these programs entails matriculation at the University of Munich or the University of Freiburg. The student must, therefore, meet their admission standards. Courses are taken in German language, literature, art, and history through Wayne State University, while additional courses are taken at the German universities.

*Regensburg, Germany.* The Vanderbilt Program at Regensburg is open to Duke students for either one or two semesters. Admission procedures are the same as those for the Munich and Freiburg programs.

*Warwick, England.* In the Warwick Exchange Program, selected Duke students spend a year in study at the University of Warwick, while students from Warwick study for the same period at Duke. The program is designed especially for majors in English. It is administered jointly by Duke and the University of Warwick.

A leave of absence from the University is granted for study abroad. Whenever possible, arrangements are made for students to register, while abroad, for the semester in which they plan to return.

From time to time, Duke University sponsors summer programs in Austria, England, France, Germany, Israel, Italy, and Spain. Students are selected competitively. Credit for not more than two courses may be earned.

A student who wishes to receive transfer credit for study abroad should take into account the following desiderata established by the faculty and administered by the Committee on Study Abroad:

1. A scholastic average of at least a B-.
2. Provisional approval to study abroad from the adviser on study abroad and the director of undergraduate studies in the major department.
3. Certification, when applicable, from the foreign language department concerned, that the student has an adequate knowledge of the language of the country in which study is pursued.
4. Approval, obtained before leaving Duke, of the appropriate director of undergraduate studies for each course to be taken abroad, as well as approval of the program by the adviser on study abroad.
5. Permission for leave of absence once program plans are complete.

Information and counsel may be obtained from the adviser on study abroad. In all cases the adviser must be informed in advance about a student's plans if credit for the work is desired.

## Other Information

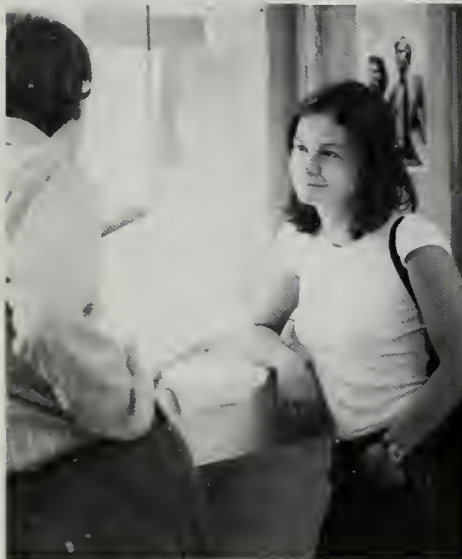
**Student Records.** Duke University adheres to a policy permitting students access to their student records, with the exception of confidential letters of recommendation received prior to January 1, 1975, and certain confidential financial information. Students may request review of any information which is contained in their student records and may challenge the content of their records by appropriate procedures. An explanation of the complete policy on student records may be obtained from the Associate Registrar.

No information contained in student records (academic or otherwise) is released to persons outside the University or to unauthorized persons on the campus, without the consent of the student. A student grants consent by signing a form which authorizes the release of data. Specific consent is required for the release of information to any person or organization outside the University, and it is the responsibility of the student to provide the necessary authorization and consent.

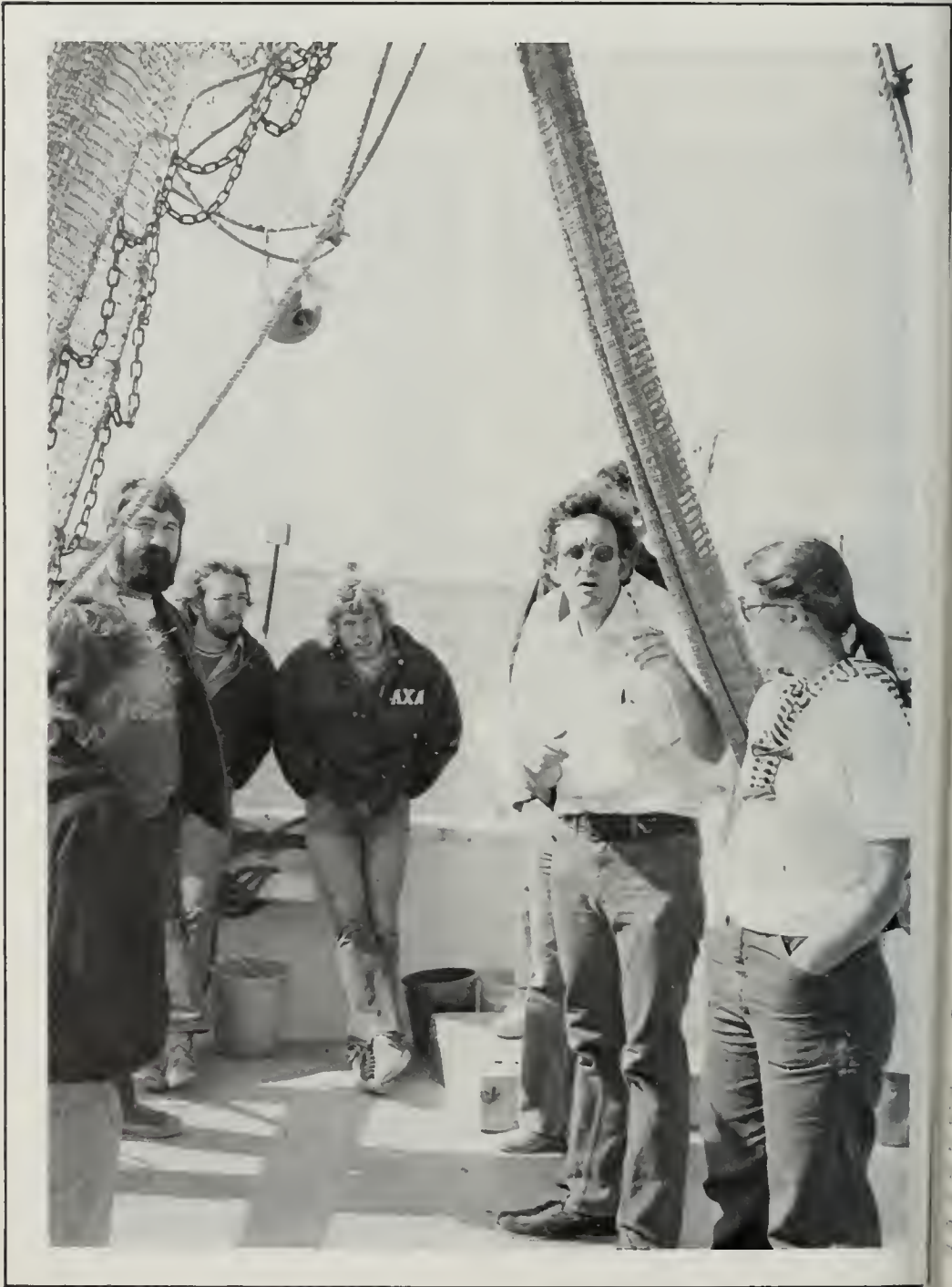


Blank forms to grant or revise the permission are available in the offices of the Dean of Student Affairs, the Dean of the School of Nursing, and the University Registrar.

**Identification Cards.** Undergraduate students are issued identification cards and semester enrollment cards which they should carry at all times. These cards are the means of identification for library privileges, University functions, and services available to University students. Students will be expected to present their cards on request to any University official or employee. The cards are not transferable, and fraudulent use may result in loss of student privileges or suspension. A student should report the loss of a card immediately to the Office of the Registrar. The cost of a new identification card is \$5.



# Cooperative Programs





## Reciprocal Agreements with Neighboring Universities

Under a plan of cooperation between Duke University and the University of North Carolina at Chapel Hill, North Carolina State University at Raleigh, and North Carolina Central University in Durham, a student regularly enrolled in Duke University and paying full fees may enroll for one approved course each semester at one of the institutions in the cooperative program. If the student takes two or more courses during a summer at Duke, one of the courses may be taken at one of the neighboring institutions under this plan.

Approval forms for courses to be taken at neighboring institutions may be obtained from the offices of the academic deans at Duke. Ordinarily, only those courses not offered at Duke will be approved. The student pays any special fees required of students at the host institution and provides transportation.

**Judaic Studies at Duke University and the University of North Carolina at Chapel Hill.** Established in 1973 and supported by Duke University and the University of North Carolina at Chapel Hill, the Cooperative Program in Judaic Studies provides the opportunity of studying Jewish civilization through a broad range of courses including Hebrew language and literature, Yiddish language and literature, the archeology of Palestine, and the history of Jewish religious thought. The program is administered by a joint planning council which also sponsors visiting speakers and professorships, library acquisitions, exchange programs with Israeli universities, summer school programs in Israel, and a publications program. Students seeking further information on the program in Judaic Studies should consult with Dr. Eric Meyers or Dr. Kalman Bland in the Department of Religion.

## Continuing Education

Adult residents of the Durham community who have an interest in resuming or beginning an undergraduate education are invited to the Office of Continuing Education for preliminary counseling. If admitted to the program in continuing education, they may apply for degree candidacy after the satisfactory completion of four courses. Guidance seminars are offered each semester for those who wish to explore their potential and to evaluate community opportunities for education, employment, and non-paid involvement. Workshops in continuing education, a series of informal discussions on issues of concern to the returning student, are



held throughout the year. Each semester a program of life-long learning courses for area residents is sponsored by the office. Conferences and workshops on a variety of topics are also held throughout the year. A program for retired professionals is also available to local residents. For further information consult the Director, Office of Continuing Education.

## Reserve Officer Training Corps

Through the Naval and Air Force Reserve Officer Training Programs, the University is cooperating with the Department of Defense in providing well-educated officers for the regular and reserve forces of the nation.

**The Naval Reserve Officer Training Corps.** Two basic programs through which students can qualify for Naval commissions upon graduation are offered. The first, the Scholarship Naval Reserve Officer Training Corps Program, provides a maximum of four years of university study largely at government expense, followed by a commission in the regular Navy or Marine Corps. The second, the College Program, leads to a commission in the Naval Reserve or Marine Corps Reserve.

*The Scholarship Program.* Scholarships are awarded on the basis of an annual nationwide test and selection procedure. Students selected are enlisted in the Naval Reserve, appointed Midshipmen, USNR, and provided four years' tuition, fees, and textbooks at government expense. In addition, they receive subsistence pay and summer active duty pay which amounts to approximately \$1,300 each year. Students in the NROTC Scholarship Program are encouraged to pursue majors in engineering (civil, electrical, or mechanical) or in specific science fields (mathematics, chemistry, physics, or computer science). Other fields of study leading to a baccalaureate degree are permitted with the approval of the Professor of Naval Science. Students participate in two summer training cruises aboard ship and receive aviation, amphibious, surface, and submarine indoctrination at Naval shore stations for one summer.

Upon graduation, students receive commissions as Ensigns in the Regular Navy, or as Second Lieutenants in the Regular Marine Corps, after which they serve with the Navy or Marine Corps as required by the Secretary of the Navy in the same manner as graduates of the Naval Academy. The minimum period of active duty is four years for regular officers.

*The College Program.* The College Program student is selected from freshmen regularly enrolled at Duke University who desire to qualify for a commission in the Naval or Marine Corps Reserve while pursuing normal courses of study. Ordinarily, they will be ordered to three years of active duty after graduation. They have the status of civilians who have entered into mutual contracts with the Navy, and are not eligible for the benefits and pay received by Scholarship Program Midshipmen. They enlist in a component of the Naval Reserve and receive subsistence pay of \$100 each month during the last two academic years. In addition, they receive active duty pay (about \$300) during the required summer cruise. This cruise normally takes place during the summer between the student's junior and senior years.

*Scholarship and College Program Students.* No distinction is made between students in the two programs in the NROTC Unit. College Program students may compete each year for the Scholarship Program. If selected, they will be appointed to scholarship status, with the attendant benefits and pay. Students in both programs are provided necessary uniforms, equipment, and Naval Science textbooks; both are furnished the same instruction, and both are required to wear uniforms on drill days and on special occasions prescribed by the Professor of Naval Science. Upon completion of their undergraduate work, students in both programs may ap-



ply for continuing studies leading to a graduate degree. If they desire, students in either program may elect the Marine Corps option at the beginning of the junior year, thereby qualifying for a commission in the Marine Corps.

*Academic Requirements for a Commission.* The academic program for an approved degree and a commission for Scholarship and College Program students must include all naval science courses offered and the following:

For NROTC scholarship students one year of calculus and one year of physics are to be completed by the end of the sophomore year. Computer Science 51 (or equivalent), History 149, Management Sciences 70, and Political Science 93, 122, or 157 are to be completed prior to graduation.

For NROTC College Program students, courses are not required in calculus, physics, or computer science, but students are urged to complete these courses in view of their career value. Completion of these courses will be considered in recommendations for scholarships made by the Professor of Naval Science. History 149, Management Sciences 70, and Political Science 93, 122, or 157 are to be completed prior to graduation. Students electing the Marine option will take, in the junior and senior years, two relevant courses approved by the Professor of Naval Science and taught by University faculty members.

**The Air Force Reserve Officers Training Corps (AFROTC).** This unit functions as the Department of Aerospace Studies. It selects, trains, and commissions college men and women who desire to serve in the United States Air Force. Two AFROTC programs exist, a four-year and a two-year program.

The four-year program consists of two segments, one covering the freshman and sophomore years and including general military courses, and the other covering the junior and senior years and including professional officer courses. These two segments are linked by a four-week summer field training encampment at selected Air Force bases. Entry into the four-year program is open to freshmen and to sophomores who are willing to make up the course work missed as a result of late entry into the program. Students entering the program as sophomores take both the freshman and sophomore courses in one year.

Applications for the two-year program should be submitted not later than the spring semester of the sophomore year. Following their sophomore year, candidates attend a six-week field-training encampment which concentrates on the course work missed during the freshman and sophomore years.

Cadets may compete for a scholarship if they desire: freshmen, for a three-year scholarship to begin with the sophomore year; and sophomores, for a two-year scholarship to begin with the junior year. Candidates for the two-year program may compete for a scholarship during the six-week summer encampment. Scholarships provide full tuition, the cost of all required books, certain fees, and a stipend of \$100 per month. All cadets, whether they hold scholarships or not, receive a tax-free stipend of \$100 per month (limited to \$2,000) during their junior and senior years.

Entry into the Professional Officer segment of the AFROTC Program entails four years of active duty and two years of reserve duty. For details on entrance and commissioning requirements, direct inquiries to the Department of Aerospace Studies.

**Army and Navy Nurse Corps Student Program.** Students in the School of Nursing may apply for appointments in the Army Student Nurse Program at the beginning of their junior year, or in the Navy Nurse Corps Candidate Program at the beginning of their senior year. The appointments carry a generous financial allowance. A student who participates for twelve months or less serves on active duty in the respective service for twenty-four months; a student who has received two years of support serves thirty-six months of active duty.

# Student Life





## Residential Facilities

It is the aim of the University to provide, through its residential program, convenient and comfortable lodging that features opportunities for informal learning and the enrichment of the total educational experience. The living units are designed to foster an intellectual atmosphere, to stimulate interest in cultural and co-curricular activities, and to provide opportunities for interaction with faculty, staff, and students from other parts of the country.

Freshmen are required to live in University residences unless they live with parents or close relatives. Residence hall accommodations are not normally available to transfer students, to former students who have been readmitted, or to part-time students. Students beyond the normal fourth year of the undergraduate program also cannot be granted space in the dormitories.

**Residences for Undergraduate Students.** Many students in Trinity College of Arts and Sciences and in the School of Engineering live in residences on the East and West Campuses and in the furnished Central Campus Apartments. Some residences, reserved for women or for men, are comprised of members of all four academic classes. Fraternities are also housed in campus residences. Some houses have men and women assigned to separate wings or floors. Another option exists in living-learning houses or corridors, where students who are admitted by application are brought together because of special interests. The living-learning situations generally are filled by upperclassmen. There are also all-freshman men's houses, which accommodate approximately one-third of the freshmen, on West Campus.

Each of the houses elects its own officers and council and organizes social, intramural, and other programs. After the freshman year, students who do not affiliate with a social fraternity may choose from among the seventeen independent houses. Many residential units are members of federations. A federation is a cluster of separate residences, usually including two houses for men and two houses for women, joined together under a faculty fellow and federation government for common academic and social programs.

Nursing students live in Hanes House and Hanes Annex. Entering students may request a double or a single room, but returning students have first choice of rooms. After the initial assignment, students arrange for room selection and roommates through the office of the Dean of Student Affairs in Nursing. Resident house





counselors, who are members of the staff of the Dean of Student Affairs, live in the dormitories; they are responsible, with the cooperation of the student government, for the administration of the residential units.

**Living Off Campus.** Students above the freshman level who wish to live off campus should apply for authorization from the appropriate dean of student affairs. Once nonresident status is approved, no guarantee can be made of a space in the dormitories should the student desire to move back on campus.

## Dining Facilities

**East Campus.** All students residing on East Campus are required to contract for their meals in the University Dining Halls each semester. Second-semester freshmen and all upperclassmen have the option of a seven-day plan of twenty-one meals each week, or a five-day (Monday-Friday) plan of fifteen meals each week. First-semester freshmen must take the seven-day plan. (See the chapter on Financial Information.) There are no provisions for changing plans during the semester. On East Campus there are two dining halls; ordinarily, the students who



reside in Southgate, Jarvis, and Gilbert-Addoms take their meals in Gilbert-Addoms; those in other East Campus dormitories take their meals in the East Campus Union. The large number of students served by the dining halls makes it impossible to provide special diets.

**West Campus and the Graduate Center.** The dining facilities on West Campus include two cafeterias with multiple-choice menus; the Oak Room, which is a full-service dining hall where meals and a la carte items are served; and a self-service snack bar, the Cambridge Inn, which is open throughout the day and evening. The Graduate Center has a public cafeteria and Gradel's, a snack bar/delicatessen, which is open until midnight.

Freshmen in the School of Nursing are required to contract for their meals in the University dining halls by the semester. Their options are the same as those offered to students residing on East Campus.

## Religious Life

Two symbols indicate the importance of the religious dimension for Duke University: *Eruditio et Religio*, the motto emblazoned on the seal of the University, and the location of the Duke Chapel at the center of the campus. People from all segments of the University and the surrounding community come together in Duke Chapel on Sunday morning to worship in a service which offers excellence in liturgy, music, and preaching. The University ministers work with the chaplains from the Roman Catholic, Protestant, and Jewish communities to provide a ministry which is responsive to the plurality of University religious interests. The traditional modes of ministry—pastoral, priestly, and prophetic inquiry—are offered in traditional and contemporary forms.

A student can find opportunity within the University community to search for meaning, to ask the ultimate questions, to worship in small communities, to meditate, to participate in contemporary liturgies, to learn from outstanding thinkers in the religious traditions, and to work to bring about a more just and humane society.

## Services Available

**Offices in Each College and School.** In Trinity College of Arts and Sciences, in the School of Engineering, and in the School of Nursing, deans, faculty members, and counselors are readily available to discuss various concerns with students and to assist them in matters relating to courses, majors, careers, cocurricular activities, and residential life. Each college and school has its own academic deans and advisers. In Trinity College of Arts and Sciences, there are academic deans for upper-classmen, according to the student's declared major or academic division, and a dean for freshmen. In the School of Nursing, each student is assigned an academic adviser for the freshman and for each succeeding year.

The School of Nursing has its own Dean of Student Affairs, whereas the Office of the Dean of Student Affairs has jurisdiction over students in Trinity College of Arts and Sciences and the School of Engineering. The Office of Black Affairs relates to the needs of all Black students at Duke.

**Student Health Service.** The objective of the Student Health Service is to provide medical care and advice to students. Both the Student Health Services Clinic and the University Infirmary are available to students for that purpose. A separate fee for this service is assessed.

The facilities of the Student Health Clinic are open during both regular and summer sessions to all currently enrolled full-time undergraduate students, as well

as to regularly enrolled students in the graduate and professional schools. For treatment of illnesses or injuries, students should first visit the Student Health Clinic. The campus bus makes regular trips to the clinic, and emergency transportation can be obtained from the Duke Public Safety Officers or from ambulance services in Durham. Residential staff personnel should be consulted, whenever possible, for assistance in obtaining emergency treatment. For a description of the specific services provided by the clinic and infirmary, see the *Bulletin of Information and Regulations*.

In addition to the Student Health Service, the University makes available a plan of Accident and Sickness Insurance to cover all full-time students who are enrolled in the University. This plan is designed to complement services normally not accessible to students through the Student Health Service coverage; it covers students both on and off campus, at home, or while traveling between home and school during the interim vacation periods throughout the one-year term of the policy.

**University Counseling Center.** The University Counseling Center provides services designed to assist individuals in gaining a better understanding of themselves and of the opportunities available to them. The professional counselors do not attempt to impose solutions on the student, but provide help in developing more effective problem-solving skills. The following are some of the areas in which counseling services are offered: choosing a career, planning programs leading to careers, identifying and overcoming educational deficiencies, developing greater self-understanding, and developing more effective social relationships.

The Counseling Center has available a wide variety of tests which may be employed in the counseling process. These tests provide measurements of general ability, scholastic aptitude, special skills, vocational aptitudes, and levels of adjustment. In the process of counseling, the student may, with the help of the counselor, choose those tests that may provide information needed to make decisions. Counseling is confidential between the counselor and student.

**Office of Black Affairs.** The Office of Black Affairs is a multi-service office of the University which attempts to assist minority students in their adjustment to student life. The office supports programs and resources which are aimed at maximizing students' chances for realizing their academic goals. Three major program components are included in these efforts.

**Summer Transitional Program (STP).** This program introduces new Black students to academic and student life at Duke. Intensive mathematics, English, and social science courses are taught to incoming students in the summer to aid in their acclimation to the Duke environment. The students are housed together on campus. If they are eligible for financial aid, all expenses of the program are covered.

**Counseling in Academic and Social Affairs (CASA).** CASA provides the ongoing leadership of a graduate counselor to each undergraduate student. The counselors visit with students on a regular basis, hold group discussions, and serve their student associates as sources of information and referral. A "house course" is also designed and taught as an aspect of the CASA program.

**Tutoring Program.** This program maintains tutors on a regular basis for any minority student seeking assistance. Although many referrals come to the tutoring program through supportive academic personnel, most are self-referrals. Tutoring is encouraged and should be arranged as soon as a need is perceived.

Black students at the University are invited to make use of the services of the Office of Black Affairs.

**Office of Placement Services.** The Office of Placement Services is the liaison between the University community and potential employers in business, education, and government. The purpose of the office is to give Duke students direction

for their careers and to help them to obtain employment commensurate with their qualifications, interests, and desires. An extensive file of openings for permanent, part-time, and summer employment is available, as is a library of general information about careers, employers, and graduate schools. Staff members are available at any time to all Duke students to discuss career plans, permanent and part-time employment opportunities, techniques of being interviewed, and other related matters.

Students who are nearing the completion of a degree and are interested in interviews with representatives from business and industry, schools and colleges, and government agencies should register with the office in September. Representatives and recruiters begin coming to Duke on October 1.

*Part-time Employment.* A listing of a wide variety of part-time job opportunities on campus and in the Durham area is maintained in the office. All students interested in working during the school year should register at the beginning of the semester. Every effort will be made to help each student find a job consistent with career interests.

*Career Counseling.* Preliminary exploration of career interests early in the student's academic career is possible, both with the career counselor and through the Career Apprenticeship Program, which offers non-paid experience in a variety of career fields. This program gives the student the opportunity to gain practical work experience and to broaden the educational experience by related field work during the undergraduate years.

## Student Activities

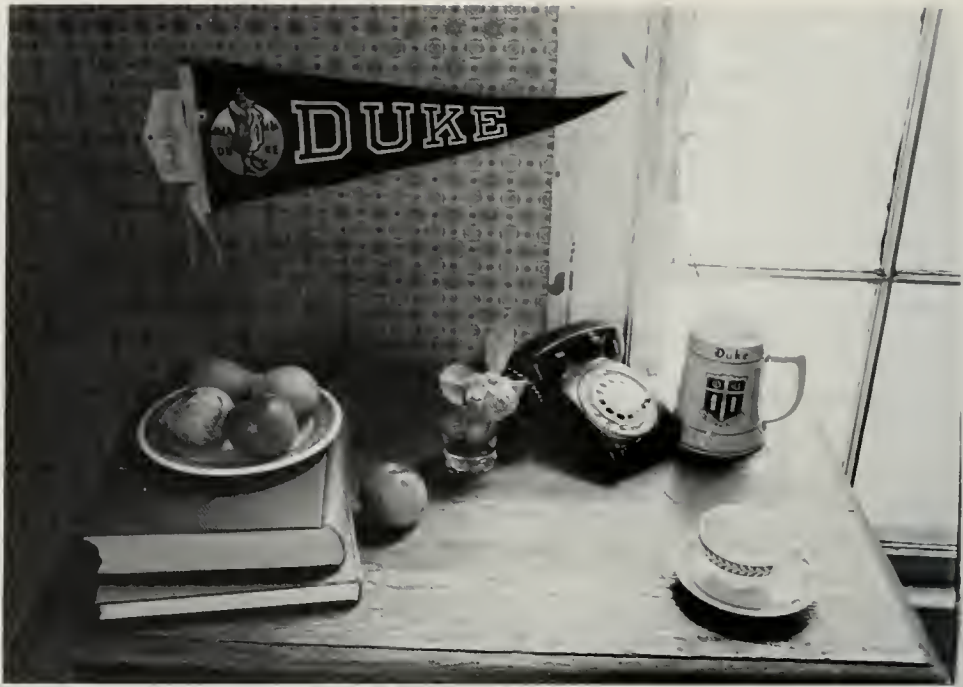
**Office of Student Activities.** The Office of Student Activities has as its responsibility the coordination of those activities, undergraduate and graduate, that transcend the individual college and schools, with a major emphasis on the development of the full range of these activities as they relate to the educational function of the University. In addition, this office is responsible for giving financial advice to student organizations in cooperation with the Office of the Corporate Controller.

**Associated Students of Duke University.** The Associated Students of Duke University (ASDU) is responsible for articulating student thought and opinion on University-wide matters and for shaping student opinion toward constructive changes in the educational process and University environment. The working philosophy of ASDU is that students have the right to make those decisions which affect primarily students.

The ASDU Legislature is composed of representatives of each of the undergraduate living groups on campus, representatives of students living off campus, and representatives of the transfer students. It fulfills a primarily administrative role—chartering student organizations, and regulating student elections and certain aspects of conduct. ASDU also attempts, on behalf of the students, to discern problems of primary concern to the student body and to take positive action in those areas. In addition, it tries to identify subtle aspects of decision-making which underlie these problems and to focus student attention on these issues.

The Executive Committee is the coordinating body of all ASDU functions. It consists of the President, four Vice-Presidents (two from Trinity College of Arts and Sciences and one each from the School of Engineering and the School of Nursing), an Executive Secretary, an Administrative Secretary, and other members appointed by the President. Various committees of ASDU, such as those concerned with residential life, academic affairs, and admissions, undertake projects for the direct benefit of the student body. A budget commission allocates all student fees to various student organizations.





**Student Project for University Development.** The Student Project for University Development (SPUD) is a service organization representing student interests in the continuing development of the University. The elected leaders of every major student organization represent their organizations on the SPUD Executive Committee. Operating independently of the University administration, the Executive Committee selects the projects which are most important to students' needs and promotes those projects by sponsoring many student activities throughout the year.

**Cultural and Social Organizations.** The scope of the more than one hundred student organizations is suggested by a partial listing of their names: Association of African Students, Alpha Phi Omega service fraternity, Bridge Club, Chess Club, Campus Crusade for Christ, Cheerleaders, International Club, Karate Club, Outing Club, Sailing Club, Students for a Democratic Society, Women's Liberation, Young Americans for Freedom, and the YM-YWCA. Sixteen national and three local social fraternities, as well as nine national sororities, are represented on campus. They are governed by the Interfraternity and Pan-Hellenic Councils, respectively.

Many opportunities are provided on campus in the areas of music and drama. The Chorale, Chapel Choir, Chancel Singers, Wind Symphony, Marching Band, Symphony Orchestra, and Collegium Musicum are examples of music organizations. Duke Players perform established and experimental drama; Hoof 'n' Horn presents musical comedy.

Most academic departments sponsor organizations and programs for students with special academic or professional interests. There are also academic and leadership honorary societies.

The Union Building, located on West Campus, is the center for student activities. It houses, among other groups, the University Union which brings students together in carrying out its stated purpose—to stimulate, promote, and develop the social, recreational, cultural, educational, and spiritual activities of the Duke University community. The Union sponsors a broad program including lectures, con-



certs, recreational activities, dances, and exhibits adapted to the leisure time interests and needs of individuals and diverse groups within the University and Durham communities.

One section of the West Campus Union houses dining facilities, the University store, grill, beer hall, soda fountain, post office, barber shop, bank, and ballroom. Offices of student organizations, meeting rooms, an information center, music and reading lounge, and recreational areas are located elsewhere in the building. Similar services and activity areas are provided on East Campus.

**Office of Cultural Affairs.** The Office of Cultural Affairs is responsible for coordinating entertainment on campus. The office is directly responsible for the Duke Artists Series and Quadrangle Pictures (35mm-film program) and for scheduling the use of Page Auditorium. Advance tickets for most events scheduled in Page Auditorium are sold at Page Box Office. The Office of Cultural Affairs also publishes yearly and weekly editions of the *Duke University Calendar*.

**Media.** The *Duke Chronicle*, the campus newspaper, publishes five issues weekly and the student-operated radio stations, WDBS-FM and WDUR-AM, produce daily programs. Three magazines and a comprehensive yearbook are published by and for students. These publications are under the direction of the Publications Board, which is empowered to choose the editors and business managers, and to review and approve the financial statements, of all franchised publications. The *DukEngineer*, the official student magazine of the School of Engineering, appears twice each semester. It contains articles on technical and semi-technical topics and other matters of interest to the School. *The Charge*, the undergraduate student handbook of the School of Nursing, is published annually by the students. It contains information and regulations of interest to students in the School of Nursing.

**Recreational Activities and Intramural Sports.** The Duke recreational and intramural programs provide all students with an opportunity to participate in some form of informal and competitive physical activity.

The men's program consists of seventeen different activities: archery, bowling, cross country, golf, handball, horseshoes, tennis, touch football, badminton, racquetball, basketball, swimming, table tennis, volleyball, wrestling, softball, and track. In a typical year more than 3,000 students compete for many intramural titles and trophies. Each year Duke, the University of North Carolina, North Carolina State, and Wake Forest meet in the annual Big Four Intramural Day.

The women's program facilitates competition in badminton, basketball, bowling, tennis, and volleyball. In addition, special events in other areas of interest are held. Various clubs, including modern dance and water ballet, offer the student opportunities to take part in extracurricular activities.

Through coed intramurals, the student is encouraged to participate on a less competitive level, promoting relaxed social and physical activity. Opportunities for coed competition are provided in the areas of badminton, table tennis, tennis, and volleyball.

The University's varied athletic and recreational facilities and equipment are available for use by students. The facilities for recreation include a golf course, lighted tennis courts, three swimming pools, a student activities building, three gymnasiums, outdoor handball and basketball courts, an all-weather track, and numerous playing fields and informal recreational areas. A variety of clubs dealing with archery, gymnastics, scuba diving, sailing, cycling, badminton, karate, rugby, soccer, and other activities are available to interested students.

**Intercollegiate Athletics.** The Athletic Department provides programs with the primary goal of fostering intercollegiate athletics by providing the best possible framework within which student athletes can compete. The department has a dual

responsibility to provide a high-quality athletic program and environment so that all students have the opportunity to compete to the fullest extent of their abilities. Duke is a member of the National Collegiate Athletic Association, the National Association of Intercollegiate Athletics for Women, and the Atlantic Coast Conference (ACC). The ACC consists of Clemson, Duke, Maryland, North Carolina at Chapel Hill, North Carolina State, Virginia, and Wake Forest.

The intercollegiate program for men at Duke University offers thirteen varsity sports. They are football, cross country, soccer, basketball, swimming, fencing, wrestling, indoor and outdoor track, baseball, golf, tennis, and lacrosse. Freshmen are eligible to participate on all varsity teams. Junior varsity programs are provided in football and basketball.

The women's athletic program provides intercollegiate competition in eight sports: basketball, fencing, golf, gymnastics, field hockey, swimming, tennis, and volleyball. Junior varsity programs are provided in tennis and field hockey.



The Director of Athletics and the Coordinator of Women's Athletics provide departmental leadership and coordinate all athletic policies with the University Athletic Council. The council consists of representatives from the undergraduate student body, the faculty, the administrative staff, and the alumni. They meet with the faculty chairman of athletics and the Director of Athletics periodically during the school year to discuss the athletic programs and make recommendations concerning athletic policies. The chairman of the council, appointed by the President of the University, is the official University representative at national and conference athletic meetings. The women's program is directed by a coordinator who serves under the leadership of the Director of Athletics.

## Judicial System and Regulations

Duke University expects and requires of all its students full cooperation in developing and maintaining high standards of scholarship and conduct. Each student is subject to the rules and regulations of the University currently in effect, or which are put into effect from time to time by the appropriate authorities of the University. At the same time, the individual is responsible for decisions and choices within the framework of the regulations of the community, as Duke does not assume *in loco parentis* relationships.

Students, in accepting admission, indicate their willingness to subscribe to, and be governed by, these rules and regulations. They acknowledge the right of the University to take disciplinary action, including suspension or expulsion, for failure to abide by the regulations or for other conduct adjudged unsatisfactory or detrimental to the University.

Responsibility for prescribing and enforcing rules and regulations governing student conduct rests ultimately with the Board of Trustees of Duke University and, by delegation, with administrative officers of the University. In the undergraduate schools, and in the University as a whole, many of these rules have been established over the years by cooperative action between students and administrative officers and, in the case of some rules, with participation of faculty members as well. Representative student organizations, such as student governments and judicial boards, and more recently, community-wide bodies of students, faculty, and administrators, have initiated proposals for policies and rules necessary to assure satisfactory standards in academic and nonacademic conduct. These proposals have been accepted by University officers and have become a substantial, if not all-inclusive, body of rules governing student life at Duke. For current regulations, refer to the *Bulletin of Information and Regulations*.

Students in Trinity College of Arts and Sciences, the School of Engineering, and the School of Nursing constitute an undergraduate community whose members are subject to the Undergraduate Community Code. Violations of the code and of certain University regulations are adjudicated before the Undergraduate Judicial Board, composed of representatives of the student body, the faculty, and the administration. The constitution of the Board, the Judicial Code of the Undergraduate Community, the procedural safeguards, and rights of appeal guaranteed to students are published in the *Bulletin of Information and Regulations* for the undergraduate community. As provided in the judicial structure of the University, each residential unit has a Judicial Board which has jurisdiction over all offenses involving violations of regulations relating to dormitory procedures and social regulations not covered by the Undergraduate Community Code or University policies and regulations. The Judicial Board of the Nursing Student Government Association (NSGA) has the major role in supervising those phases of community living which directly concern the welfare of the students in the School of Nursing.



# Admission







## Principles of Selection

James B. Duke, in his Indenture of Trust, requested that “great care and discrimination be exercised in admitting as students only those whose previous record shows a character, determination, and application evincing a wholesome and real ambition for life.” In this light, and in view of the institution’s limited enrollment, Duke University looks beyond the basic characteristics of academic competence possessed by the majority of applicants. It seeks, in each prospective student, regardless of race, sex, color, religion, or national origin, not only evidence of intellectual promise and maturity of judgment, but also a degree of positive energy. Often, this energy is expressed in the form of special talents and accomplishments; it is seen consistently in a student’s determination to make creative use of the opportunities and challenges posed by Duke University.

## Requirements for Application

Although there are no inflexible requirements as to subject matter, students are urged to choose a broad and challenging high school program. At least twelve units of acceptable college preparatory work must be presented for review. Applicants to the School of Engineering are advised to take four units of mathematics and at least one unit of physics or chemistry.

The Scholastic Aptitude Test, given by the College Entrance Examination Board, and three Achievement Tests (one of which must be in English composition) are required of all candidates for freshman admission and must be taken before the application deadline. Since placement in language study can be determined by an achievement test score, it is recommended that a candidate who expects to continue study in a foreign language take the CEEB Achievement Test in that language. Candidates may submit results of the American College Testing Assessment Program (ACT), provided the test is taken prior to the application deadline; the scores must be made available to the Admissions Committee thirty days before the decision date. Candidates for the School of Engineering who elect to take the CEEB test battery are required to take the Achievement Test in Mathematics.

## Application Procedures

Application forms and a *Bulletin of Information for Prospective Students* may be obtained from the Office of Undergraduate Admissions, Duke University, Durham, North Carolina 27706. A nonrefundable processing fee of \$20 must accompany the completed application form.

A personal interview at Duke is not required for admission; students who find it possible to visit the campus, however, may write for an interview or participate in one of the group information sessions held during particularly busy periods. Interviews cannot be guaranteed during the early months of the year, when applications are under review.

**April Notification.** Candidates for admission to the freshman class must apply no later than February 1 of their senior year in secondary school and normally do so during the preceding autumn. Decisions are mailed from the University by April 15, and accepted candidates are expected to reserve a place in the class by May 1.

**February Notification.** Students who indicate on their applications that they wish to learn of their admissions decisions by February 1 of their senior year must observe a December 15 application deadline. Results of the Scholastic Aptitude Test and achievement tests (or the ACT) taken through December may be submitted for review. Applicants for February notification are urged to apply concurrently to other colleges, although those who are accepted by Duke in February must pay the registration and room deposit fees by February 15 to reserve a place in the class. Because neither of the two notification dates is intended to be more competitive than the other, students who receive negative decisions in February should not request that their applications be reviewed once again in April.

**Midyear Admission.** Midyear admission allows a limited number of freshmen to begin their college work a semester early or to postpone matriculation for a semester. Midyear applicants are expected to complete all the requirements for fall admission. The application deadline for new candidates is October 15; students will be notified of the decision on their applications by November 15, with the expectation that those who are accepted will reply by December 1.

**Transfer Admission.** Transfer admission from other accredited institutions may be arranged for a limited number of students each semester. Because the transcript of at least a full year of academic work is preferred by the Admissions Com-



mittee, and because transfer students are required to spend their last two years at Duke, most candidates apply to Duke during their third or fourth semester in college. Candidates submit official transcripts of all work completed at other accredited colleges, scores on the Scholastic Aptitude Test, and employment records if there has been an extended period of employment since graduation from secondary school. See page 40 concerning evaluation of transfer credit.

All transfer students should expect to be responsible for their own housing arrangements. The Office of Housing Management provides assistance to students who seek housing and/or roommates.

September transfer students meet the February 1 application deadline, learn of their decisions by April 15, and respond to the University by May 1. January transfer students apply by October 15, learn of their decisions by November 15, and reply to the University by December 1. Transfer students for the School of Nursing are accepted only for September admission; they must complete all transfer application processes by February 1.

**Nondegree Students.** A few individuals are permitted to enroll as nondegree students in most of the courses open to degree students, but under no circumstances can places in courses be preempted for them. These students are given academic and career counseling by the Office of Continuing Education; they are subject to most of the regulations set forth for degree candidates. Nondegree applications may be obtained from the Office of Undergraduate Admissions and should be submitted to that office, accompanied by a \$20 application fee, by July 15 for the fall semester and by December 1 for the spring semester.

At least four courses must be completed successfully before a nondegree candidate may apply for degree candidacy. Students who plan to complete the four courses should not expect automatic admission to the University. More detailed information is available from the Office of Continuing Education, 107 Bivins Building, Duke University, Durham, North Carolina 27708.

**Readmission of Former Students.** A student who desires to return, following withdrawal from college, should apply to the appropriate college or school. See page 51 for readmission procedures and dates. Students who have been withdrawn from the University for five or more years must submit a new application to the Director of Undergraduate Admissions.





# Financial Information







## Tuition and Fees

No college or university can state honestly that an education at the college level is inexpensive. However, fees paid by students cover less than half the cost of their instruction and the operation of the University. Income from endowment and contributions from alumni and other concerned individuals meet the balance and assure each student the opportunity to pursue an education of unusually high quality.

Students are urged to give their attention first to the selection of institutions which meet their intellectual and personal needs, and then to the devising of a sound plan for meeting the cost, including a knowledge of the University's financial aid program, as well as their family's own resources. A brochure describing in detail the various forms of financial aid may be obtained from the Office of Undergraduate Financial Aid, Duke University, Durham, North Carolina 27706.

**Estimated Expenses for an Academic Year.\*** Certain basic expenditures, such as tuition, room, and board, are to be considered in preparing a student's budget. These necessary expenditures, with a reasonable amount allotted for miscellaneous items, are shown below:

Tuition	\$3,230†
Residential Fee	
Single room	\$845-\$1,010
Double Room	\$630-\$745
Food	
Seven-day board plan	\$913
Five-day board plan	\$785
Cafeteria estimate	\$980
Books and Supplies	\$220

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\*The figures contained in this section are projected and are subject to change prior to the beginning of the fall, 1977, semester.

†For juniors and seniors in the School of Nursing, the tuition is \$3,430.

It should be realized that additional expenses will be incurred which will depend to a large extent upon the tastes and habits of the individual. The average Duke student, however, can plan on a budget of \$5,500 for the academic year. Travel costs, clothing purchases, and other major expenditures would have to be added to this estimate.

**Debts.** No records are released, and no students are considered by the faculty as candidates for graduation, until they have settled with the Bursar for all indebtedness. Bills may be sent to parents or guardians provided the Bursar has been requested in writing to do so. Failure to pay all University charges on or before the times specified by the University for that semester will bar the student from class attendance until the account is settled in full.

**Registration Fees and Deposits.** On notification of acceptance, students are required to pay a nonrefundable first registration fee of \$20 and to make a deposit of \$100. The deposit will not be refunded to accepted applicants who fail to matriculate. For those who do matriculate, \$50 of the deposit serves as a continuing room deposit for successive semesters, and the remaining \$50 serves as a continuing registration deposit.

**Late Registration.** Continuing students who fail to register during the registration period must pay a fee of \$25 to the Bursar.

**ROTC Deposit.** An Air Force ROTC deposit of \$10 is required of students enrolling in air science to cover possible loss of military equipment issued to them. This deposit is refunded to the student upon return of issued equipment.

**School of Nursing.** Special nonrefundable laboratory and health fees are charged as follows: sophomores—\$30; juniors—\$25; seniors—\$30. The health portion of this fee is not a student health insurance fee, but a charge which covers laboratory tests and a physical examination for students beginning and ending their clinical experience. These physical examinations must be conducted at Duke University. A declaration of satisfactory health is required by the School, for personal protection of the student, and by affiliating clinical agencies; it is also required for registration applications completed at the end of the program. The laboratory portion of the fee includes the cost of a stethoscope. Additional medical fees may be required for certain nursing electives.

**Part-Time Students.** In the regular academic year students who register for not more than two courses in a semester are classified as part-time students. Part-time students will be charged at the following rates: one course, \$323; half course, \$161.50; quarter course, \$80.75; one course plus laboratory or precept, \$430.67. Registration for more than two courses requires payment of full tuition. Graduate students registered for undergraduate courses will be assessed three units for non-laboratory courses and four units for laboratory courses. Men and women in nondegree programs who are being considered for admission to degree programs, as designated by the Office of Continuing Education, pay fees by the course whether the course load is one, two, or three courses.

**Auditors.** Auditing one or more courses without charge is allowed for students paying full fees, provided that the consent of the instructor is obtained. Students who are enrolled for one or two courses may audit other courses by payment of \$40 for each course audited. With the consent of the appropriate instructor and the Director of Continuing Education, graduates of Duke may audit undergraduate courses for \$40 per course.

**Duke Employees.** Full-time employees with one or more years of service with the University may request permission to take for credit or audit up to two courses during any one semester. Permission may be granted based on the individual mer-

its and circumstances of each application. Employees receiving permission to take such courses for credit will be charged one-half the tuition rate shown above for part-time students. Courses may be audited upon payment of \$40 per course. Employees are required to submit a formal application by December 1 for the spring semester, or July 15 for the fall semester.

**Fees for Course Changes and Transcripts.** Changes in registration for courses may be made without a drop/add fee if they are made during the first week of classes. Any change made after the first week of classes requires a payment of \$1.50 for each change made. Requests for transcripts of academic records should be directed to the Associate Registrar. Ten days should be allowed for processing. A minimum fee of \$2, payable in advance, is charged for a single copy. A charge of fifty cents will be made for each additional copy on the same order to the same address.

## Living Expenses\*

**Housing.** In dormitories for undergraduate students other than nursing students, the housing fee for a single room ranges from \$845 to \$1,010 for the academic year; for a double room, the fee ranges from \$630 to \$745 per occupant. In the Graduate Center, the housing fee for a single room is \$695 for the academic year; for a double room, it is \$520 for each occupant.

The residential units of the School of Nursing are Hanes House and Hanes Annex. The housing fee for a single room is \$930 for the academic year; for a double room, it is \$695 for each occupant.

To reserve University housing for the fall semester, returning students who are eligible for, and wish to occupy, such housing must make a \$50 prepayment of the housing fee at a designated time during the spring semester.

Detailed information concerning the student's obligations under the housing contract and the consequences of failure to comply are published in the *Bulletin of Information and Regulations*.

**Food Services.** See the section on Food Services on page 62 for a description of dining facilities on both campuses and the options or requirements for board contracts. The charge for board is \$456.50 per semester on the seven-day plan or \$393 per semester on the five-day plan, payable at the time of registration.

## Refunds

In the case of withdrawal from the University, the student may elect to have tuition, as well as room and board (if applicable), held as credit for later study, or refunded according to the following schedule:

<i>Withdrawal</i>	<i>Refund</i>
Before classes begin	Full amount
During first or second week	80 percent
During third, fourth, or fifth week	60 percent
During sixth week	20 percent
After sixth week	None

In the event of death, or involuntary withdrawal to enter the armed services, refunds will be made on a pro-rata basis.

The \$50 registration deposit will be refunded to students whom the University does not permit to return, who graduate, or who request the refund prior to regis-

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\*The figures contained in this section are projected and are subject to change prior to the beginning of the fall, 1977, semester.

tration, thereby indicating their intention not to return for the following semester. The registration deposit will not be refunded to students who register for the following semester but fail to enter.

Arrangements for refund of the \$50 room deposit are described in information furnished to each student by the Housing Bureau.

## Student Aid

It is the policy of Duke University to provide adequate financial aid for all students when evidence of need exists. The amount of financial assistance approved for an individual varies directly with financial need. The amount of need is determined according to widely accepted principles recommended by the College Scholarship Service.

For the student with demonstrated need, the net cost of an education at Duke University will generally be no greater than that for college attendance at a private institution elsewhere. It is the intention of the Office of Undergraduate Financial Aid to set each award at a level which will enable a student to meet all the costs of attending Duke University, taking into consideration the contribution that can reasonably be expected from the student, the family, and any available outside sources. During the current academic year, approximately one-third of the student body received more than four million dollars in scholarship or loan funds.

**Financial Aid for Entering Freshmen.** Candidates should initiate their application for financial aid concurrently with their application for admission during the fall semester of their senior year in secondary school. Instructions concerning the specific requirements and deadline dates will accompany application materials. The Parents' Confidential Statement must be submitted to the College Scholarship Service. This form may be obtained either from a high school guidance counselor or from the Financial Aid Office. A certified copy of the parents' current Federal Income Tax Form 1040 must also be submitted.

A student in residence who is receiving financial assistance based upon need may not register an automobile on campus during the academic year for which the aid is granted without special permission for an appropriate reason. Requests for permission to register a car must be submitted to the financial aid office.

**Renewal of Financial Aid after the Freshman Year.** Each year students must file an application for renewal of financial aid. This application must include a new Parents' Confidential Statement and a certified copy of the parents' current Federal Income Tax Form 1040.

To have financial aid renewed, a student must be in good academic standing with the University. A. B. Duke and J. A. Jones Scholars are expected to maintain an average considerably higher than the minimum.

**Types of Financial Aid.** Gift scholarships or grants, long-term loans, and employment are integral parts of the financial aid program, and some portion of the aid offered an undergraduate is normally in each of these forms. In 1976-1977, the self-help portion consisted of an \$800 loan and a job paying \$750. Acceptance of a gift scholarship does not require the student to undertake the loan or job portions of the award. Duke has several scholarships based on need which are available from personal endowments and corporations. Some are intended for entering freshmen, whereas others are awarded to upperclassmen. These scholarships may be based on achievement in a particular field or on an outstanding overall record.

**Gift Scholarships.** The following are among the named gift scholarships offered through Duke University:

*Angier B. Duke Memorial Scholarships.* Recipients of these awards are stu-





dents whose superior records mark them as young men and women who give promise of becoming outstanding leaders in their chosen fields of endeavor. Candidates for admission to the freshman classes in Trinity College of Arts and Sciences, the School of Engineering, and the School of Nursing are eligible to apply. Forty are usually available for each freshman class with a value of \$1,000 to \$5,000 annually, depending upon financial need. There are also three scholarships of equal value available for a student's junior and senior years. Rising juniors are invited to apply for this scholarship prior to the beginning of the second term of the sophomore year. In addition, Angier B. Duke scholars are given the opportunity to participate in a seven-week summer-tutorial program at Oxford University.

*W. N. Reynolds Memorial Scholarships.* Recipients of these awards are students of outstanding ability and need who have made superior records and show promise of constructive leadership. In considering candidates for the awards, consideration will be given in the following order:

1. Children of employees of R. J. Reynolds Tobacco Company or any of its affiliates or subsidiaries.
2. Children of families residing in Forsyth County, North Carolina.
3. Other candidates who are residents or natives of North Carolina.

Number available: four for each freshman class.

Value: \$500 to \$4,300 annually.

*A. J. Fletcher Scholarships.* These Music Department scholarships are given to students who can demonstrate, by tape or audition, talent and achievement in instrumental or vocal performance. These awards range between \$500 and \$1,200 per year, depending on need, and are renewable annually for up to four years. Although recipients are not required to major in music, they are expected to study privately and to participate in departmental performing groups.

*United Methodist Scholarships.* A number of United Methodist Scholarships, valued at \$500 per year, are available on a basis of demonstrated need to Methodist students who have given evidence of leadership in their local Methodist Youth Fellowship Groups.

*Alice M. Baldwin Scholarships.* One or more of these scholarships, varying in amount from \$200 to \$1,000, are awarded to rising seniors in Trinity College of Arts and Sciences on the basis of scholarship, character, and leadership.

*Evelyn Barnes Memorial Scholarship.* One \$400 or two \$200 grants are awarded to undergraduate women who are contributing to the musical life of the University. Scholarship, character, and leadership are considered. Recommendation by a member of the music faculty is required.

*Panhellenic Scholarship.* A scholarship of approximately \$500 is awarded to an upperclass woman in Trinity College of Arts and Sciences on the basis of scholarship, character, leadership, and service.

*Delta Delta Delta Scholarship.* A scholarship of \$200 is awarded by Delta Delta Delta to an undergraduate woman on the basis of scholarship and character. The winner of this award is eligible to compete for the national award of a Delta Delta Delta Scholarship of \$1,000.

*Sandals Scholarship.* A scholarship of approximately \$200 is awarded to a rising sophomore woman in Trinity College of Arts and Sciences, on the basis of scholarship, character, leadership, and potential for contributions to the University community.

*Welch Harriss Scholarships.* Recipients of these scholarships will receive \$1,000 per year without reference to need. If demonstrated need exceeds \$1,000, the scholarship will be adjusted accordingly. These awards are made to male freshmen who have achieved outstanding academic records. They are renewable each year as long as the student remains in good academic standing. Consideration will be given in the following order: (1) students from High Point; (2) students from Guilford County, North Carolina; and (3) students from North Carolina.

*Florence K. Wilson Scholarships.* Grants-in-aid are made each year from the Florence K. Wilson Scholarship Fund to nursing students qualifying for financial assistance. This fund was established in 1961 by combining the School of Nursing's Alumnae Association Fund, the students' Florence K. Wilson Scholarship Fund, and contributions from the Wilson family and friends.

*Alyse Smith Cooper Scholarships.* Each year six or more scholarships of various amounts are awarded to students demonstrating both talent and need. Preference is given to students from Alamance County, North Carolina. Majors in music and art, particularly students of piano, organ, and voice receive special consideration.

*Braxton Craven Endowed Scholarships.* Recipients of these scholarships will receive \$3,500 per year without reference to need. If demonstrated need exceeds \$3,500, the scholarship will be adjusted accordingly. Braxton Craven scholars will be chosen on the basis of outstanding academic and extracurricular achievement. First preference is given to Davidson County, North Carolina, residents and second preference to students from North Carolina. The scholarships are approved on a continuing basis, providing satisfactory academic progress is achieved.

*Marian Sanford Sealy Scholarship Fund.* Established in 1966 with an initial gift from the Durham-Orange County Medical Auxiliary, the Marian Sanford Sealy Scholarship is awarded to a student indicating financial need. Personal qualifications supportive of potential to become an outstanding nurse and a distinguished academic record are the criteria for the awarding of this scholarship.

*Lelia R. Clark Scholarship in Nursing.* The Duke Hospital Auxiliary established the Lelia R. Clark Scholarship in Nursing in 1971 to cover tuition and fees for a nursing student, preferably one from North Carolina. Prerequisites for the award are a commendable academic record, financial need, and exemplification of the qualities of a person committed to serving others.

*Federal Nursing Grants.* Funds provided by the federal government are available in limited amounts for grant awards to qualified nursing students.

*J. A. Jones Memorial Scholarships.* The scholarships, sponsored through the Jones Fund for Engineering, are awarded to engineering students whose outstanding academic and personal qualifications suggest that they will become leaders in a technological society. The awards range from a yearly sum of \$500 to \$3,600, depending on the degree of need.

*Robert H. Pinnix Scholarships.* The Robert H. Pinnix Scholarships are awarded annually to two upperclassmen enrolled in the Duke School of Engineer-



ing. The award is based upon demonstrated ability, excellence in engineering, and financial need.

*Scholarships for Foreign Students.* A limited number of awards will be made each year to qualified students from other countries who enter either as freshmen or as students with advanced standing. Candidates for these awards are required to submit the Application for Scholarship and Financial Aid and the Parents' Confidential Statement of the College Scholarship Service provided by the Office of Undergraduate Admissions and Financial Aid of Duke University. Two named awards bring foreign students to the campus: the Carol Cranmer Scholarship (named for a former student) and the Roberta Florence Brinkley International Scholarship (named for a former dean).

*The Mary Duke Biddle Scholarship in Music Composition.* This scholarship with a stipend of \$2,500 per year is available to a member of each entering class. It is renewable from year to year so long as the student does satisfactory work. Students wishing to apply for this award will be required to submit examples of their composition. Eligibility is limited to students planning to major in music.

*AFROTC College Scholarship Program.* Students can apply for three-year scholarships during their freshman year and two-year scholarships during their sophomore year. Scholarships are available to male students who qualify for flight training and to both male and female students who major in certain scientific or engineering fields. The scholarships include tuition, fees, and textbook reimbursement, plus a \$100 per month tax-free allowance.

*NROTC College Scholarship Program.* This program provides for up to four years' tuition and textbooks, laboratory fees, and a \$100 per month stipend. These scholarships, based upon academic achievement, leadership potential and overall performance, can be awarded at any stage of the student's college career through either a nationwide selection or by the Professor of Naval Science at the University. In addition, two other two-year scholarships are available to rising juniors: one leads to a career in nuclear power, and the other follows a summer attendance at the Naval Science Institute at Newport, Rhode Island. For further information on any of the above scholarship programs, contact the Professor of Naval Science.

*North Carolina Legislation Tuition Grant.* The North Carolina General Assem-





bly established a program of tuition grants available to North Carolina residents who are full-time students at in-state private colleges and universities. The grant for each eligible student is \$200.

*The Minnie Happer Pruden Scholarships.* These scholarships are available to the daughters of Episcopal clergymen.

*The Huguenot Scholarship.* A scholarship of \$1,000 per year is available from the Huguenot Society of America to a descendant of a Huguenot.

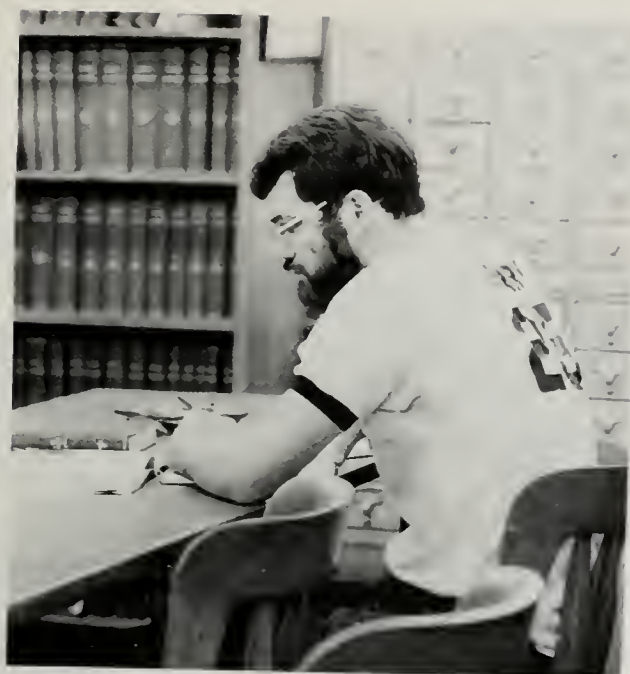
**Loans.** The loan programs which are available to students through Duke University are listed below:

*National Direct Student Loan Program.* Loan funds supplied by the federal government through Part E of Title IV of the Higher Education Act of 1965 are available to qualified students. Repayment of loans under this act normally begins nine months after the student is graduated or leaves college, with complete payment scheduled within a ten-year period. Interest accrues at the rate of 3 percent annually, commencing nine months after the borrower ceases to be a full-time student at an institution of higher education. This loan is part of the student's financial aid award.

*Nursing Loans.* Loan funds supplied by the federal government are available to qualified students in the School of Nursing. Interest accrues at the rate of 3 percent annually, commencing nine months after the student ceases to be a full-time student. A certain percentage of the loan is forgiven for each year the student serves as a professional nurse. This loan is part of the nursing student's financial aid award.

*Federal Guaranteed Insured Loan Program.* Under the Higher Education Act of 1965, Congress established the Federal Guaranteed Insured Loan Program, designed to guarantee and insure student loans. These loans are made by banks or other incorporated state lending agencies, with enrollment of the student certified by the school or college. The interest is 7 percent. Students who qualify will have the interest paid by the government while they are in school. Duke University is a guaranteed lender.





**Remission of Tuition.** Children of ministers in the North Carolina and the Western North Carolina Annual Conferences of the United Methodist Church may be eligible to receive a partial tuition grant of \$1,500 for a maximum of eight semesters of undergraduate study at Duke University. Eligibility is met by the parent being in a regular pastoral appointment and resident in one of the conferences. When the parent is in a special appointment and resident in one of the conferences, eligibility will be determined on an individual basis, depending upon the nature of the appointment. In all cases the decision of the University will be final.

**Employment.** Most financial aid recipients are offered a job as part of their aid package. These jobs require between nine and fifteen hours a week and provide an average stipend of \$700. The money is paid directly to the student. The Office of Placement Services maintains part-time employment listings for the campus and Durham area. All students interested in working during the school year should register at the beginning of the semester. Every effort will be made to help students find jobs consistent with their interests.

Duke University also expects that students receiving financial aid will work during their summer vacation. In the summer before entering college, a freshman should save \$500 for use during the first year of college. In subsequent summers, the student should save \$700 to be used for college expenses.

**Paying the Bills.** Many families finance a college education with the assistance of an insured tuition payment plan regardless of whether they receive financial assistance from Duke. Although these plans are sponsored by a number of private firms, the University refers parents to plans provided by the Richard C. Knight Insurance Agency, Inc. The company provides the University with the full sum required each semester and arranges a schedule for monthly repayment by the subscribing families. The schedules for repayment vary with the program offered by the company. Additional information on this particular tuition payment plan may be obtained by writing to Richard C. Knight Insurance Agency, Inc., Insured Tuition Payment Plan, Sixth Street-James Avenue, Boston, Massachusetts 02116.

# Courses of Instruction





## Definition of Terms

Introductory-level courses are numbered below 100; advanced-level courses are numbered 100 and above. Courses numbered 1 through 49 are primarily for freshmen; courses numbered from 200-299 are primarily for seniors and graduate students. (See page 42 for regulations governing enrollment of other students in 200-level courses.)

Odd-numbered courses are usually offered in the fall semester; even-numbered courses in the spring semester. For courses which will be offered in 1977-78, consult the Official Schedule of Courses, available in the Registrar's Office. Double numbers separated by a hyphen indicate that the course is a year course and must normally be continued throughout the year if credit is to be received. Double numbers separated by a comma indicate that although the course is a year course, credit may be received for either semester without special permission. The following symbols, suffixed to course numbers, identify the small-group learning experiences: *S*, seminar; *P*, preceptorial; *T*, tutorial; *D*, discussion section.

## Air Force Aerospace Studies

For courses in Air Force Aerospace Studies, see the Reserve Officers Training Program.

## Anthropology

Professor Friedl, *Chairman*; Associate Professor Apte, *Director of Undergraduate Studies*; Professor Fox; Associate Professors Cartmill, Hylander, O'Barr, and Rosen; Assistant Professors Glander, Graedon (Nursing), Quinn, Smith, and Stack (Public Policy Sciences)



Students without necessary prerequisites listed for a course may request the consent of the instructor for admission.

**93. Human Origins.** Origins and distribution of mankind; primate evolution; a survey of human paleontology and human biology, prehistory, and language; and the origins of human social organization and culture. One course. *Staff*

**94. Elements of Cultural Anthropology.** The dynamics of culture and society; form and function of social institutions. Emphasis is upon primitive societies. Primarily meant for students not majoring in the social sciences. One course. *Staff*

**99. Cultural Anthropology.** Introductory study of culture, society, and human behavior with emphasis on theory and ethnography. Designed for social science majors and recommended for anthropology majors. One course. *Staff*

**101, 102. Introduction to the Civilization of Southern Asia.** (See Interdisciplinary Course 101, 102.)

**107. Introduction to Linguistics.** Origin and nature of language; methods of descriptive linguistics with reference to historical and comparative linguistics. Prerequisite: sophomore standing. (Also listed as English 107.) One course. *Apte, Butters, or Hull*

**115. Sex Roles in Evolutionary Perspective.** Bases for differentiation of tasks and power allocated to the sexes among hunters and gatherers, horticulturists, pastoralists, and plow agriculturists. Prerequisite: Anthropology 94 or 99. One course. *Friedl, Quinn, or Smith*

**116. Language, Ethnicity, and New Nations.** Examination of problems facing newly independent countries of Asia and Africa in developing national integration; from the theoretical perspectives of sociolinguistics and anthropology. Prerequisite: Anthropology 94 or 99. One course. *Apte*

**117. Language, Law, and Politics.** Theories of language in political and legal processes, bilingualism, strategic use of language, political rhetoric, discrimination through language. Primary ethnographic materials from the United States and Canada. Prerequisite: Anthropology 94 or 99. One course. *O'Barr*

**119. Language, Culture, and Society.** Analysis of language behavior within and across societies relating variations in linguistic usage to sociocultural factors: ethnosemantics, social dialects, and ethnography of speech. Prerequisite: Anthropology 94 or 99. One course. *Apte or Rosen*

**123. Peoples of the World: Mediterranean Europe.** Emphasis on economic developments and change in rural communities and on the urbanization of migrants. Prerequisite: Anthropology 94 or 99. One course. *Friedl*

**124. Peoples of the World: American Indian.** A comprehensive survey of the Indians of North and South America, including a study of origins and prehistory, archeology, racial affiliations, languages, material culture, social and political organization, economics, and religion, discussed in terms of the "culture area." One course. *Staff*

**125. Peoples of the World: Africa.** A survey of the indigenous cultures and societies of Africa and the study of kinship, politics, economics, religion, and sociocultural change. Prerequisite: Anthropology 94 or 99. One course. *O'Barr*

**126. Peoples of the World: Oceania.** Selected problems in the development of



pre-European and post-European cultures. The relationships between man and Pacific environments. Prerequisite: Anthropology 94 or 99. One course. *Staff*

**127. Peoples of Mesoamerica.** Development and organization of diverse societies and institutions in Mexico and Guatemala. Prerequisite: Anthropology 94 or 99. One course. *Smith*

**129. Peoples of the World: Middle East.** Emphasis on language, kinship, economics, politics, and religion. Prerequisite: Anthropology 94 or 99. One course.

**130. Social and Cultural Change.** Contemporary theories of change, including innovation, acculturation, and modernization. Prerequisite: Anthropology 94 or 99. One course. *O'Barr or Smith*

**131D. Principles of Archeological Investigation.** (Also listed as Religion 131D.) One course. *Meyers*

**132. Human Evolution.** Evolutionary biology of the primates. Anatomical and behavioral adaptations and phylogeny of fossils and living primates including *homo sapiens*. Prerequisite: Anthropology 93 or equivalent. (Also listed as Anatomy 231.) One course. *Cartmill or Glander*

**133. The Effects of Colonialism and Neo-Colonialism on Native Peoples.** The effect of governmental policies and interests, dominant populations, and local and international economic concerns on indigenous peoples, whether living as enclaves in nation states or as dependencies. One course. *Quinn and Smith*

**134. Political Anthropology.** Comparative study of politics and government in tribal and peasant societies. Evolution of political systems. Political changes resulting from contact and colonialism. Prerequisite: Anthropology 94 or 99. One course. *O'Barr or Smith*

**135. Anthropological Research in American Culture.** Substructures in American society studied by ethnographic field methods. Prerequisite: Anthropology 94 or 99. One course. *Quinn*

**137. Kinship and Social Organization.** Anthropological study of kinship relations and social groups: family, marriage, residence, terminology, descent, and alliance. Prerequisite: Anthropology 94 or 99. One course. *Staff*

**139. The Anthropology of Complex Society.** Historical development and theoretical directions of anthropological research on such topics as peasant communities, urban neighborhoods, ethnicity, and other institutions in complex societies. Ethnographic examples from Asia, Europe, the United States, and Canada. One course. *Fox or Friedl*

**140. Myth and Ritual, Literature and Drama.** Symbolic action and expressive culture among tribal, caste, class, and industrial societies. Intensive case study using the various approaches, including diffusionism, archetypes, functionalism, French structuralism, and cultural interpretation. One course. *Staff*

**141. Peoples of the World: Southeast Asia.** Major social, cultural, and religious systems—Hindu-Buddhism and Islam—and examples of populations relatively isolated from the historical expansion of these systems. Emphasis placed on island Southeast Asia. Prerequisite: Anthropology 94 or 99. One course. *Staff*

**142. Peoples of the World: South Asia.** Survey of indigenous cultures and societies of India, Pakistan, Sri Lanka, Bangladesh, Nepal, and Bhutan with emphasis on social institutions, behavioral patterns, value systems, and sociocultural change. Prerequisite: Anthropology 94 or 99. One course. *Apte or Fox*

**143. Primate Biology.** A comprehensive survey of primate feeding strategies and and general ecology. One course. *Glander*

**144. Evolutionary Study of Behavior.** Phylogenetic comparison of communication, infant socialization, aggression, and sexual behavior as they pertain to species group structure. Emphasis on primates. One course. *Glander*

**146. Cross-Cultural Perspectives on Health Care Delivery.** (Also listed as Nursing 146.) *Dietz and Graedon*

**150. Law and Anthropology.** Adjudication and dispute settlement in primitive and small-scale societies. Western legal developments compared with those of new nations. American legal problems from the anthropological perspective. Prerequisite: Anthropology 94 or 99. One course. *Rosen*

**162. Cultural Ecology.** Human interaction with the environment and the effect of ecology on social structure. Prerequisite: Anthropology 94 or 99. One course. *Smith*.

**164. Peasantry and Peasant Movements.** The genesis of peasant movements. Forms of peasant protest and its role in the economic, political, and ritual life of societies. Case studies from Western and Eastern societies, past and present. Prerequisite: Anthropology 94 or 99. One course. *Fox or Smith*

**165. Psychological Anthropology.** The mutual relevance of anthropology to child development, social learning, small-group interaction, cognition. Prerequisite: Anthropology 94 or 99. One course. *Quinn*

**166. Introduction to Archeology: Man and Culture.** Modern methodology and analysis; theories of cultural evolution; survey of world prehistory with an exploration of the uses of ethnographic analogy. Prerequisite: Anthropology 93, 94, or 99. One course. *Staff*

**170. Economic Anthropology.** Traditional economic systems, including land tenure, division of labor, exchange, leveling mechanisms and markets; the response of traditional economies to forces such as population pressure, migratory labor, plantation agriculture, and agricultural innovation. Prerequisite: Anthropology 94 or 99. One course. *Quinn or Smith*

**185T, 186T. Junior Tutorial.** Prerequisites: Anthropology 94 or 99 and consent of the Director of Undergraduate Studies. Half-course or one course. *Staff*

**193. Independent Study.** Directed reading and research. Open only to qualified students in the senior year, with consent of the Director of Undergraduate Studies. One course. *Staff*

**195S, 196S. Senior Seminar.** Prerequisites: Anthropology 94 or 99 and any 100-level course in anthropology, as well as consent of the Director of Undergraduate Studies. Half-course or one course. *Staff*

### For Seniors and Graduates

**210. Linguistic Anthropology: Theory.** Examination and comparison of predominant schools of language study—comparative-historical, structural, transformational, stratificational, and generative semantics. Prerequisite: Anthropology 107 or consent of instructor. One course. *Apte*

**211. Linguistic Anthropology: Ethnography of Communication.** Verbal and

nonverbal communication from linguistic and anthropological perspectives with emphasis on synchronic and diachronic aspects of communication, development of sociolinguistic theory and its application to intra- and intercultural communicative processes. Prerequisite: Anthropology 107 or consent of instructor. One course. *Apte*

**220S. Society and Culture in India.** The basic features of Indian cultures and societies from an anthropological perspective. The impact of selected technological and social changes upon the individual, caste, and community. Prerequisite: Anthropology 94 or 99 or consent of instructor. One course. *Apte* or *Fox*

**222. Topics in African Anthropology.** Research problems illustrated through ethnographic studies of African societies. One course. *O'Barr*

**242. Topics in Prehistory.** Anthropological issues derived from archeological and early historical investigations. Prerequisite: Anthropology 166 or consent of instructor. One course. *Staff*

**243. Theory and Method in Archeology.** Techniques of geochronology, environmental reconstruction, sociocultural reconstruction, and statistical analyses applied to problem areas in archeology—human cultural origins, Paleolithic and post-Pleistocene readaptations, origins of agriculture and civilization. Prerequisite: Anthropology 166 or consent of instructor. One course. *Staff*

**244. Primate Behavior.** Examination of the social behavior of prosimians, monkeys, and apes in an attempt to understand the evolutionary development of the order primate and the origin of man. One course. *Glander*

**245. Functional and Evolutionary Morphology of Primates.** History and functional significance of locomotor and feeding adaptations, craniofacial morphology, sense organs, and reproductive systems in primates, including *homo sapiens*. Prerequisite: Anthropology 132 (Anatomy 231) or equivalent, or consent of instructor. (Also listed as Anatomy 238.) One course. *Cartmill* or *Hylander*

**246. The Primate Fossil Record.** Evolution of man and other primates as inferred from fossil remains. Prerequisite: a course in human evolution or consent of instructor. One course. *Cartmill* or *Kay*

**249. Topics in Economic Anthropology.** Prerequisite: Anthropology 94 or 99 or consent of instructor. One course. *O'Barr*, *Quinn*, or *Smith*

**250. The Anthropology of Cities.** Organization and behavior of men in urban centers analyzed from an evolutionary perspective; cross-cultural analysis of cities and their varying roles. Prerequisite: Anthropology 94 or 99 or consent of instructor. One course. *Fox*

**251. Ethnography of Humor.** Examination of theoretical framework, research methods, and data-collection techniques for the analysis of humor with the goal of discerning normative behavioral patterns, expectations regarding social roles, interpersonal relationships and social institutions, and the nature of ideologies and world views, within and across cultures. Prerequisite: Anthropology 94 or 99 or consent of instructor. One course. *Apte*

**259. Linguistic Anthropology: Language Acquisition.** Biological basis of human linguistic capacity; major theoretical positions in linguistics; acquisition of semantics, syntax, and phonology in English and other languages. Prerequisite: Anthropology 107 or consent of instructor. One course. *Staff*

**264. Primitive Religion.** The ethnology, social functions, and the socio-psychological meanings of religion in primitive societies. One course. *Staff*

**265. Personality and Society.** The sociology and social psychology of human personality, its origins in the primary group, its nature and varieties, and its integrations into secondary group institutions. One course. *Staff*

**266. Personality and Culture.** The influence of culture patterns and social institutions upon character structure, socialization of the individual, and the dynamics of human personality. Comprehensive anthropological materials will be drawn upon. One course. *Staff*

**267. Cognitive Anthropology.** Theoretical and methodological developments in the study of taxonomies, naturally occurring categories, information-processing rules, decisions, and belief systems. Psychological testing of non-Western people; effects of schooling. Prerequisite: Anthropology 94 or 99. One course. *Quinn*

**268. Law and the American Indian.** Survey of the legal status and problems of the contemporary American Indian. Topics include the basis and extent of tribal sovereignty, the relation of states and their Indian citizens, treaties and Indian claims actions, the legal context of economic development, and the legal position of Eastern American Indians. One course. *Rosen*

**269. Topics in Law and the Social Sciences.** Examination of the relation between law and the social sciences. Topics will be chosen each semester from among the following: the use of social science data by American courts, the legal and social basis of property holding, the development of legal institutions in the new nations, experimentation with human subjects, and domestic relations and the American legal system. One course. *Rosen*

**270. Ethnographic Field Methods.** Research strategies and techniques for field research; participation in a field project in a local community. One course. *O'Barr or Quinn*

**271. Methods of Data Analysis.** Quantitative analysis of anthropological data. One course. *Quinn*

**272. Primitive Music.** A comparative ethnological study of non-Western music, emphasizing different scales (mode, raga, magam, lu) conventions, styles, social functions, and cultural contexts; some attention to the African origins of jazz. Sufficient technical background will be provided for the non-specialists. One course. *Staff*

**273. Primitive Art.** A comparative ethnological study of non-European art and artists emphasizing media, conventions, social functions, and cultural contexts. One course. *Staff*

**275. Rank, Power, and Authority in Pre-Industrial Societies.** The role and development of social, economic, and political stratification in specific societies in Oceania, Africa, and the New World. Prerequisite: major in anthropology or graduate standing. One course. *Fox*

**276. Analysis of Kinship Systems.** Primitive relationship categories as related to legal norms and social groupings. Theoretical issues and contrasting approaches to the analysis of social classification terminologies. One course. *Staff*

**277. Class, Ethnicity, and Public Policy.** (Also listed as Public Policy Studies 275.) One course. *Stack*



**278S. Special Topics in Political Anthropology.** Current research problems. Topics will change each semester. Prerequisite: Anthropology 134 or consent of instructor. One course. *O'Barr or Quinn*

**280S, 281S. Seminar in Selected Topics.** Special topics in methodology, theory, or area. Prerequisite: consent of instructor. Two courses. *Staff*

**291, 292. Anthropological Theory.** Theoretical, methodological, and comparative issues. Prerequisite: consent of instructor. Two courses. *Fox or Quinn*

## DEPARTMENTAL MAJOR

**Major Requirements.** Eight courses in the department, two of which must be 93, 94, or 99 and at least two of which must be senior-graduate courses.

An anthropology major normally takes at least four related courses in departments recommended by the anthropology adviser. Such courses are usually in the Departments of Anatomy, Art, Botany, Economics, History, Mathematics, Political Science, Psychology, Sociology, and Zoology.

**Honors.** Qualified majors are encouraged to participate in special work leading to graduation with distinction in anthropology. (See the section on Honors in this *Bulletin* for general requirements.) Any major with a *B+* average in anthropology courses and with a *B* average in all courses is eligible. Students who desire to undertake honors work should request a member of the anthropology faculty to recommend their names to the Director of Undergraduate Studies. To receive departmental honors a major must complete a paper involving significant independent research or scholarship and pass an oral examination on the paper conducted by an appointed committee of faculty members, at least two of whom should be in anthropology. Normally, students will prepare their papers over the course of the senior year working in close collaboration with their committees and receiving on the average two course credits in independent study for the work.

## Art

Professor Markman, *Acting Chairman and Director of Undergraduate Studies*; Professors Jenkins, Mueller, and Sunderland; Associate Professor Stars; Assistant Professors Brown, Connolly, Lichtenstein, and Pratt; Instructor Smullin; Part-time Lecturer van Dijk; Part-time Instructors Menapace, S. Pratt, and White

## HISTORY OF ART

Introductory courses in art history (Art 61 through 66) are designed as studies in the development of architecture, sculpture, painting, and minor arts as material manifestations of Western culture from ancient to modern times, with some reference to primitive, Oriental, and other non-Western cultures. A student receives instruction in the history of art and in methods of art historical analysis. Credit may not be allowed for more than two courses in the sequence. Introductory courses are open to freshmen and to upperclassmen.

**61. Introduction to the History of Architecture and Sculpture.** One course. *Staff*

**62. Introduction to the History of Painting and Sculpture.** One course. *Staff*

**63. Introduction to Ancient Art.** Architecture, sculpture, and painting from ancient Egypt through the Roman period. One course. *Markman*

**64. Introduction to Medieval Art.** Development of architecture, sculpture,

painting, and related arts (mostly Christian) from about 300 A.D. to about 1400. Prerequisite: Art 61, 62, or 63. One course. *Sunderland*

**65. Introduction to Renaissance and Baroque Art.** Development of architecture, sculpture, and painting in Western Europe from about 1400 to about 1750. Prerequisite: Art 61, 62, or 63. One course. *Jenkins*

**66. Introduction to Modern Art.** Development of architecture, sculpture, and painting in Europe and America from about 1750 to the present. Prerequisite: Art 61, 62, or 63. One course. *Brown or Connolly*

**131. Art and Archeology of the Hellenic World.** Preliminary treatment of archaeological material from the Aegean, the geometric, and orientalizing periods, followed by the architecture, sculpture, and vase paintings of ancient Greece from archaic through Hellenistic times. Not open for credit to students who have taken Classical Studies 55. One course. *Markman*

**132. Roman Art and Archeology.** The archeological background for the formation of the Roman style as derived from Etruscan, Greek, and indigenous Italian sources; followed by the architecture, sculpture, and painting from the early Republic to the end of the Empire in Italy and in the provinces. Not open for credit to students who have taken Classical Studies 56. One course. *Markman*

**133. Medieval Architecture.** A survey of Christian architecture in the Near East, the Balkans, Russia, and Western Europe from the beginnings of the medieval style in the late classical period to its disintegration in the fifteenth century. One course. *Sunderland*

**134. Medieval Painting and Sculpture.** A study of painting, including mosaics, manuscripts, stained glass, and sculpture in Western Europe from the late classical period through the fourteenth century. One course. *Sunderland*

**135, 136. Art of Northern Europe in the Fifteenth and Sixteenth Centuries.** First semester: Netherlandish, French, and Spanish painting with some reference to Franco-Flemish illumination. Second semester: German, Austrian, and Bohemian painting, graphic arts, and sculpture. Two courses. *Mueller*

**137, 138. Italian Renaissance Art.** A consideration of Italian sculpture and painting in the fourteenth, fifteenth, and sixteenth centuries. First semester: the art of the fourteenth and fifteenth centuries. Second semester: the sixteenth century. Prerequisite: Art 61 or 62 or the consent of instructor. Two courses. *Jenkins*

**140. Seventeenth-Century Painting and Sculpture in Europe.** Evolution of the Baroque style in European painting and sculpture, with some attention being given to related manifestations in the late sixteenth and early eighteenth centuries. Particular emphasis is laid on developments in Flanders, France, Holland, and Spain. Prerequisite: Art 61 or 62 or 65 or consent of instructor. One course. *Jenkins*

**141, 142. American Art.** A survey of architecture, sculpture, and painting from the time of the first settlers to the present, including the contributions of the English, Dutch, French, and Spanish to the artistic heritage of the United States. Two courses. *Brown or Connolly*

**1435. History of Prints and Drawings.** Fifteenth century to the present. Prerequisite: Art 62, 65, or 66 or consent of the instructor. One course. *Mueller*

**144. Renaissance and Baroque Architecture.** A study of the development of Renaissance architecture in Italy from its beginnings in the fifteenth century in the works of Brunelleschi to its flowering in the seventeenth-century Baroque works of

Bernini and Borromini; along with a consideration of the spread of Italian Renaissance forms to northern Europe in the sixteenth century and its development into a Baroque style in the seventeenth century. One course. *Sunderland*

**146. Recent Interpretations of Contemporary Art.** The appraisal of critical art historical issues through the study and discussion of the visual arts and their criticism since World War II. Prerequisite: Art 66, or consent of instructor. One course. *Connolly*

**147. Painting and Sculpture in the Eighteenth and Nineteenth Centuries.** An investigation of the development of painting from the final stages of the Baroque in the eighteenth century to the period of the Impressionist movement in the last decades of the nineteenth century. One course. *Sunderland or Connolly*

**148. Modern Painting and Sculpture: 1863 to 1905.** The rise of the anti-academic movements of Impressionism, Divisionism, Symbolism, and the Art Nouveau. Emphasizes Manet, Van Gogh, Gauguin, Seurat, and Cezanne. Prerequisite: Art 62 or 66. One course. *Brown, Connolly, or Lichtenstein*

**149. Pre-Columbian Art and Archeology.** Architecture, sculpture, pottery, and other arts of the indigenous civilizations in Mexico, Central America, and the Andean region of South America before the Spanish conquest. One course. *Markman*

**150. Latin American Art.** Architecture, painting, sculpture, and other arts. Emphasis on the architecture of the colonial period. One course. *Markman*

**165. Painting and Sculpture: 1905 to the Present.** Evolution and interaction of major European and American movements. Prerequisite: Art 148 or consent of instructor. One course. *Brown*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified students in the junior year, by consent of the Director of Undergraduate Studies. Two courses. *Staff*

**193, 194. Independent Study.** Directed reading and research. Open only to qualified students in the senior year, by consent of the Director of Undergraduate Studies. Two courses. *Staff*

#### **For Seniors and Graduates**

**233. Early Medieval Architecture.** The development of religious architecture from the time of Constantine to the end of the First Romanesque style in the third quarter of the eleventh century. One course. *Sunderland*

**237. French Renaissance Art.** Sixteenth-century painting and sculpture in France with special emphasis on Italian influences. Prerequisites: some knowledge of Italian Renaissance art and the ability to read French, or consent of instructor. One course. *Jenkins*

**244. Neoclassicism.** Origin and evolution of neoclassicism in the visual arts emphasizing comparison to contemporary stylistic alternatives and international aspects of the style. Prerequisite: Art 66 or consent of instructor. One course. *Connolly*

**247. Problems in the History of Graphic Arts.** Selected topics in the history of prints and drawings. One course. *Mueller*

**249. Problems in Pre-Columbian Art and Archeology.** Architecture, sculpture, and other arts of the indigenous civilizations in Mexico, Central America, and the Andean region. Prerequisite: consent of instructor. One course. *Markman*

**250. Problems in Latin American Art.** Architecture, painting, sculpture, and other arts with emphasis on colonial architecture of Central America. Open to seniors who have a reading knowledge of Spanish and/or have had courses in Latin American history, economics, or literature. One course. *Markman*

**254. Problems in Modern Architecture.** A particular movement, master, or idea studied as a problem in criticism and methodology; influence on design and building. Prerequisite: Art 61 or consent of instructor. One course. *Brown*

**257, 258. Problems in Modern Art.** Selected topics in nineteenth- and twentieth-century European art, with emphasis on one or more major movements or masters. Prerequisite: Art 66 or 148 or consent of instructor. Two courses. *Lichtenstein*

**259. Romanticism.** Emphasis on the French school of painting; sources in English, German, and Spanish art. Prerequisites: knowledge of nineteenth-century art and ability to read French; or consent of instructor. One course. *Lichtenstein*

**293, 294. Special Problems in Art History.** Individual study and research. Two courses. *Staff*

## DESIGN

**53. Drawing.** Directed approaches to practice in life drawing and in the expression of graphic concepts. Prerequisite: consent of instructor. One course. *S. Pratt and Smullin*

**54. Two-Dimensional Design.** Experiments in form and color, with work from observation. Introduction to color theory in painting and two-dimensional media. Prerequisite: Art 53 or consent of instructor. One course. *S. Pratt*

**56. Three-Dimensional Design.** An introduction to studio exploration of sculpture. Visual experience in an exploration of form: from point, line, and plane to space, mass, and time. Perceptual, structural, analytical, synthetic, and fantastic approaches. Prerequisite: Art 53 or consent of instructor. One course. *Smullin*

**151, 152. Photography.** Emphasis on interaction of technique, perception, and communication in making and responding to photographic images. Some work with view cameras furnished by the department; students must provide own hand camera. Prerequisites: submission of portfolio; Art 53 or consent of instructor. Two courses. *Menapace*

**153, 154. Painting.** Studio practice in painting with individual and group criticism and discussion of important historic or contemporary ideas. Prerequisites: Art 54 (or equivalent) and consent of instructor. Two courses. *V. Pratt*

**155, 156. Advanced Drawing and Color.** Work from life or in formal modes, with emphasis on personal development, through individual and group criticism and discussion. Prerequisites: Art 53 and 54 and consent of instructor. Two courses. *V. Pratt*

**159, 160. Printmaking.** Wood engraving, block printing, copperplate engraving, etching, aquatint, and drypoint. Prerequisites: Art 53-54 or consent of instructor. Two courses. *White*

**161, 162. Sculpture.** Realistic modeling in clay from human model. Work in abstract modes. Introduction to casting, carving, and welding. Second semester: independent problems. Prerequisite: Art 56 or consent of instructor. Two courses. *Smullin*



**164. Ceramics.** Design, production, and conceptualization of three-dimensional forms. One lecture and four studio hours each week. One course. *Stars*

**171, 172. Advanced Sculpture.** Prerequisites: Art 161 and 162. Two courses. *Smullin*

**173, 174. Advanced Painting.** Prerequisites: Art 153 and 154 and consent of instructor. Two courses. *V. Pratt*

**181, 182. Individual Project.** Independent work open to highly qualified seniors on recommendation of the instructor and invitation of the department. Two courses. *Staff*

**ELECTIVE FOR ART MAJORS**

**119. Fine Arts Photography Laboratory.** History and development of photography as documentation and art; use of materials, techniques, laboratory, and studio practice. Open only to art majors. A fee of \$25 will be charged, payable upon notification from the Bursar's Office at the beginning of the semester. Half-course. *van Dijk*

**DEPARTMENTAL MAJOR**

The student will elect a sequence of courses emphasizing either the history of art or design. The department offers work leading to graduation with distinction. See the section on Honors in this *Bulletin*.

**Major in History of Art**

*Prerequisites.* Two courses from the sequence 61-66 of which at least one must be 61 or 62.

*Major Requirements.* Eight courses above the 60-level of which two must be at the 200-level. Majors must complete two years of college-level study, or equivalent, of a foreign language. Students contemplating graduate study in art history are advised to acquire a reading knowledge of at least two foreign languages, one of which should be German.

**Major in Design**

*Prerequisites.* Introduction to art history, two courses from the sequence 61-66; Art 53-54.

*Major Requirements.* Five studio courses exclusive of Art 53-54.

*Studio Fees.* To cover materials supplied in design courses, a fee of \$40 per semester for all courses will be charged, payable upon notification from the Bursar's Office at the beginning of each semester.

**Asian and African Languages**

**CHINESE**

**131, 132. Elementary Chinese.** Four hours of classroom work and two hours of language laboratory drill. Two courses. *Kunst*

**133, 134. Intermediate Chinese.** Four hours of classroom work and two hours of language laboratory drill. Two courses. *Kunst*

**135, 136. Introduction to Modern Chinese Literature.** Prerequisite: Chinese 133, 134, or equivalent. Two courses. *Kunst*

**141. Chinese Literature in Translation.** Masterpieces of traditional Chinese poetry, fiction, and drama. One course. *Kunst*

## HINDI-URDU

**171, 172. Studies in Indian Literatures.** Readings in translation. First semester: classical Indian literary traditions. Second semester: literatures from Indian languages, including novels, poetry, and drama, with special reference to European literary influences. Two courses. *Shonek*

**173, 174. Literature and Revolution.** Post World War I literatures of Asia and Africa in the context of contemporary sociopolitical revolutions. Readings in English. Two courses. *Shonek*

**181, 182. Intensive Elementary Hindi-Urdu.** Four hours of classroom work; two hours of language laboratory drill. Concentration on the acquisition of conversational ability in Hindi-Urdu, with a grammar and vocabulary basic to both Hindi and Urdu. Introduction to the Devanagari script and the reading of graded texts. Two courses. *Shonek*

**183, 184. Intensive Intermediate Hindi-Urdu.** Four hours of classroom work, two hours of language drill. Advanced conversation in Hindi-Urdu reading and composition. Prerequisite: elementary Hindi-Urdu. Two courses. *Shonek*

**185, 186. Advanced Hindi Reading and Composition.** An introduction to scholarly and literary Hindi prose and extensive practice in composition. Prerequisite: Hindi-Urdu 183, 184, or equivalent. Two courses. *Shonek*

## JAPANESE

**151, 152. Elementary Japanese.** Four hours of classroom work and two hours of language laboratory drill. Two courses. *Kunst*

**153, 154. Intermediate Japanese.** Four hours of classroom work and two hours of language laboratory drill. Two courses. *Kunst*

**155, 156. Introduction to Modern Japanese Literature.** Prerequisite: Japanese 153, 154, or equivalent. Two courses. *Kunst*

**161. Modern Japanese Fiction in Translation.** Readings of twentieth-century Japanese novels and short stories. One course. *Kunst*

## SWAHILI

**101, 102. Elementary Swahili.** Three hours of classroom work, plus language laboratory drill. Two courses. *Houpe*

**103, 104. Intermediate Swahili.** Three hours of classroom work and language laboratory drill. An advanced study of language and Swahili culture and literature. Two courses. *Houpe*

## Astronomy

For courses in Astronomy, see *Physics*.

## Biology

**11-12. Principles of Biology.** A two-semester introduction to the discipline open only to freshmen and sophomores who have had no more than one year of biological science in high school. (Entering freshmen will be given priority.) Lectures and laboratories. Two courses. *Staff*

**11P, 12P. Preceptorials.** Elective preceptorials for students enrolled in Biology 11, 12. *Staff*

**14. Principles of Biology.** A one-semester introduction to the discipline open to freshmen with at least one year of biological science in high school and to all upperclassmen. Lectures and laboratories. (Offered in fall and spring terms.) One course. *Staff*

**14P. Preceptorial.** Elective preceptorial for students enrolled in Biology 14.

The above offerings, 11-12 and 14, may not both be taken for credit; either is an acceptable prerequisite for advanced courses. See other courses listed under *Botany and Zoology*.

### Interdepartmental Concentration

An interdepartmental program (e.g., in cell and molecular biology, physical biology, and marine biology) may be pursued instead of a departmental major. The appropriate director of undergraduate studies in botany or zoology will arrange administrative responsibility for such programs.

## Black Studies

Mr. Turner, *Acting Director*; Associate Professor Gavins; Assistant Professor Burford

Black studies is designed to provide instruction and study directed toward the experience and concerns of Black America. Though a major is worthwhile and encouraged, many of the course offerings complement other majors and serve also as essential components of a liberal arts education.

Courses in Black studies may count toward the distributional requirements. The distributional division for each course follows the description.

**99. Dimensions of Racism.** The nature of racism, its interconnection with aspects and institutions of American life and its effects. (Humanities.) One course. *Staff*

**100. Philosophy of Black Liberation.** (Humanities.) One course. *Staff*

**113. African Philosophy.** Religious and political philosophy of twentieth-century Africa. (Also listed as Religion 113; Humanities.) One course. *Staff*

**145, 146. Afro-American History.** The Black experience in America from slavery to the present. (Also listed as History 145, 146; Social Sciences.) Two courses. *Gavins*

**147. The Black in the City.** (Also listed as Sociology 147; Social Sciences.) One course. *Preiss*

**150. Third World Literature.** Selected works with special emphasis upon Black American, African, and Caribbean writers. (Humanities.) One course. *Staff*

**151. Classic Literature of Black America.** Works by Black authors of the Negro

renaissance followed by Wright's *Native Son* and Ellison's *Invisible Man*. (Humanities.) One course. *Staff*

**152. Contemporary Literature of Black America.** Essays, poetry, and fiction by contemporary Black writers. (Humanities.) One course. *Staff*

**176, 177. Marxism and Black Liberation.** Marxist perspective on the liberation of Black America. (Humanities.) Two courses. *Staff*

**185S. Black Studies.** African influence on Western civilization. (Humanities.) One course. *Staff*

**189S. Special Topics.** (Humanities or Social Sciences.) One course. *Staff*

**191, 192. Independent Study.** (Humanities or Social Sciences.) Two courses. *Staff*

**193, 194. Independent Study in Community or Field Work.** (Humanities or Social Sciences.) Two courses. *Staff*

## THE MAJOR

Black Studies 99 and 100 are required for the major and strongly recommended as introductory course work in Black studies. Black History 145, 146, 193, and 194 are required. (It is suggested that the students seek their own community assignments and request approval.) Three other courses above 100 are to be selected. One must be a seminar; and one may be 193 or 194, but not both.

Students majoring in Black studies will receive special counseling in planning their course of study and in considering their future vocation.

## Botany

Professor Wilbur, *Chairman*; Professor White, *Director of Undergraduate Studies*; Professors Anderson, Billings, W. Culberson, Hellmers, Johnson, Naylor, Philpott, and Stone; Associate Professors Antonovics, Barber, Boynton, Knoerr, Searles, and Strain; Assistant Professors Christensen and Siedow; Lecturer C. Culberson

See *Biology* for a listing of introductory courses.

The *L* suffix on a course number indicates that the course includes a laboratory. Note that in some courses the laboratory is optional, and a student may register for these courses with (e.g., Botany 135L) or without (e.g., Botany 135) the laboratory.

**43. Ecology and Society.** Ecological concepts and their application to human society. Not open to majors in a natural science. One course. *Hellmers*

**51L. Culture and Propagation of Plants.** Principles of physiology, genetics, ecology, and taxonomy as applied to horticulture. Lectures, greenhouse and garden work, and field trips. Prerequisite: introductory college biology. One course. *Philpott*

**53. Introductory Oceanography.** Basic principles of physical, chemical, biological, and geological oceanography. Prerequisite: one course in a laboratory science. (Also listed as Geology 53.) One course. *Pilkey (Geology) and Searles*

**75. Plants of the Southeast.** Survey of the flora, stressing biological and geological factors related to present day floristic and evolutionary patterns. One course. *Stone*



**90. Plants and Man.** The co-evolution of agriculture and civilization; the invention of elite races of domesticated plants from wild species by artificial selection. The economic botany of the world's major crops. One course. *Culberson or Wilbur*

**103L. General Microbiology.** A study of the morphology and fundamental physiological processes of bacteria: their relationship to sanitation, public health, soil fertility, and food preservation. Prerequisite: introductory biology. One course. *Johnson*

**135. Evolutionary Systematics.** Evolutionary mechanisms in speciation and phylogeny in plants and animals: geographic and reproductive isolation, breeding systems, hybridization, homology, convergence, and extinction. Assessment of modern techniques (cytotaxonomy, chemotaxonomy, numerical taxonomy) in classification. Complements Botany 186, Botany 286, Zoology 186 and Zoology 286. Lectures. Prerequisite: college biology. (Also listed as Zoology 135 and Zoology 235.) One course. *Bailey (Zoology), Lundberg (Zoology), and Stone*

**135L. Evolutionary Systematics.** See Botany 135. Lectures and laboratory. One course. *Bailey (Zoology), Lundberg (Zoology), and Stone*

**141. Ecology and Humanity.** Fundamentals of ecology and their application in the conservation and use of global resources. Open only to majors in a natural science. One course. *Strain*

**142L. Systematics.** Principles of vascular plant taxonomy with practice in collection and identification of the local flora. Lectures, laboratories, and field trips. One course. *Wilbur*

**145L. Plant Diversity.** Major groups of the living plants, their evolutionary origins and phylogenetic relationships. Prerequisite: introductory biology. One course. *Culberson and White*

**146L. Plant Ecology.** Principles of the relationships between plants and their environments. Structures and processes of ecosystems. Laboratory, lectures, and field trips. Prerequisites: introductory biology and one other course in biology. One course. *Billings, Christensen, or Strain*

**151L. Plant Physiology.** Principal physiological processes of plants, including respiration, photosynthesis, water relations, and factors associated with plant morphogenesis. Prerequisites: introductory college biology and one year of chemistry; organic chemistry is desirable. One course. *Siedow*

**160L. Plant Anatomy.** A comparative study of basic cell types, tissues, and organs of vascular plants. Correlation of anatomical information with pertinent literature, application of anatomy to problems in systematics and evolution, and the interrelationship between structure and function. Prerequisite: one year of biology or consent of instructor. One course. *White*

**169L. The Marine Environment.** (For description see Marine Sciences.)

**180. Principles of Genetics.** Structure and properties of genes and chromosomes, and evolution of genetic systems. Lectures. Prerequisites: introductory biology, Chemistry 12, and Mathematics 31 or their equivalents. (Also listed as Botany 280, Zoology 180, Zoology 280, and under the University Program in Genetics.) One course. *Antonovics, Boynton, and Gillham (Zoology)*

**180L. Principles of Genetics.** See Botany 180. Lecture and laboratories. One course. *Antonovics, Boynton, Gillham (Zoology), and Ward (Zoology)*

**186. Evolutionary Mechanisms.** Evolutionary mechanisms in population ecology and population genetics of plants and animals: natural selection, adaptation, species interactions, mating systems, fitness concepts, and genetic divergence. Complements Botany 135 and Zoology 235. Prerequisite: college biology. (Also listed as Zoology 186, Botany 286, Zoology 286, and under the University Program in Genetics.) *Antonovics and H. Wilbur (Zoology)*

**191, 192. Independent Study.** Directed reading and research. Open to qualified students in the junior and senior years by consent of department. Credit to be arranged. *Staff*

**193T, 194T. Tutorial in Botany.** Credits to be arranged. *Staff*

**195S, 196S. Seminar in Botany.** Credits to be arranged. *Staff*

### For Seniors and Graduates

**203. Cytogenetics.** Organization and variation of chromosomes in relation to genetics and evolution. Meiotic behavior and variation, chromosomal rearrangements, polyploidy, karyotype evolution, and mechanisms of chromosomal changes. Prerequisite: one year of biology. One course. *Anderson*

**203L. Cytogenetics.** See Botany 203. Lectures and laboratories. One course. *Anderson*

**204L. Marine Microbiology.** The major groups of marine microorganisms, their taxonomy, culture, physiology, and ecology. Prerequisite: a course in introductory biology or botany. (Given at Beaufort.) One and one-half courses. *Staff*

**206L. Anatomy of Woody Plants.** Primary and secondary structures in seedlings and in mature trees, shrubs, and vines. Preparation techniques for gross observations, and for study of micro and ultrastructures with light and electron microscopy. Relationship of microstructures to growth habits and physical properties of woody plant parts. Comparative studies in relation to ecological and systematic topics. (Also listed as Forestry 206.) Prerequisite: college botany or biology. One course. *Philpott*

**207L. Microclimatology.** (Also listed as Forestry 204.) One course. *Knoerr*

**209L. Lichenology.** Morphology, systematics, and biological and ecological implications of the lichens. Collection and identification of specimens and the use of lichen chemistry in taxonomy. One course. *W. Culberson or C. Culberson*

**210L. Bryology.** Morphological, systematic, and ecological characteristics of mosses and liverworts. One course. *Anderson*

**211L. Marine Phycology.** An introduction to marine algae; their identification, taxonomy, morphology, physiology, and ecology. Field trips complemented by laboratory study, culturing, and preparation of herbarium material. (Given at Beaufort.) One and one-half courses. *Searles*

**212L. Phycology.** Morphological and ecological characteristics of common freshwater and marine algae and principles of their classification. One course. *Searles*

**214L. Biological Oceanography.** See Zoology 214. (Given at Beaufort.) One and one-half courses. *Barber*

**217L. Environmental Instrumentation.** (Also listed as Forestry 217.) Prerequisite: consent of instructor. One course. *Knoerr*

**221L. Mycology.** Field and laboratory study of vegetative and reproductive structures of the fungi and slime molds. Methods of collection, isolation, propagation, and identification of the major orders as represented in local flora. Prerequisite: one year of biological science. One course. *Johnson*

**225T, 226T. Special Problems.** Students with adequate training may do special work in the fields listed below. Credit to be arranged.

1. Cytology; Bryology. *Anderson*
2. Genetics. *Antonovics*
3. Ecology. *Billings*
4. Genetics. *Boynton*
5. Ecology. *Christensen*
6. Lichenology. *Culberson*
7. Physiology. *Hellmers*
8. Bacteriology; Mycology. *Johnson*
9. Physiology. *Naylor*
10. Anatomy and Morphology of Vascular Plants. *Philpott*
11. Phycology. *Searles*
12. Systematics of Flowering Plants. *Stone*
13. Ecology. *Strain*
14. Anatomy and Morphology of Vascular Plants. *White*
15. Systematics and Taxonomy of Vascular Plants. *Wilbur*
16. Physiology. *Siedow*

**233. Microbiology.** Introduction to bacteriology, virology, cell biology, and immunology. Structure, metabolism, and growth of bacteria; the properties of bacterial and animal viruses; and basic immunology. (Also listed as Microbiology 233.) One course. *Amos (Microbiology), Burns (Microbiology), Joklik (Microbiology), or Willett (Microbiology)*

**236S. Major Global Ecosystems.** Study of a single global ecosystem such as arctic-alpine, desert, tropical rainforest, grassland, or coniferous forest, including the place and effects of both primitive and modern man. One course. *Billings*

**248. Introductory Biochemistry.** The chemistry of proteins, lipids, carbohydrates, and nucleic acids; metabolic interrelationships of these compounds. Prerequisite: Chemistry 151, one year of college physics (second semester may be concurrent), and Mathematics 32. (Also listed as Biochemistry 248.) One course. *Staff*

**250L,S. Plant Biosystematics.** Descriptive and experimental procedures used to assess systematic implications of vascular plant evolution. Laboratory, discussion, and field oriented problems. Prerequisites: basic courses in systematics and genetics. One course. *Stone*

**253. Advanced Plant Physiology.** Physiological consequences of physical principles as related to ion transport, water relations, and the interconversion of energy in plant cells. One course. *Naylor and Siedow*

**256. Physiological Role of Minerals and Water.** Availability, uptake, transport, and function of minerals and water in plant growth. Prerequisite: Botany 151L or equivalent. One course. *Hellmers*

**257S. Principles of Plant Distribution.** Interpretation of floristic and ecological plant geography. Prerequisite: Botany 146L or equivalent. One course. *Billings*

**258. Physiology of Growth and Development.** Consideration of the internal factors and processes leading to the production of new protoplasm and its differentiation at the cellular, tissue, and organ level in plants. Lectures. Prerequisite: Botany 151L or equivalent; organic chemistry is recommended. One course. *Naylor*

**261. Photosynthesis.** Principles of plant physiology applied to the study of

photosynthesis: developmental, mechanistic, regulatory, and ecological aspects of the photosynthetic process. Prerequisite: Botany 151L or 251L. One course. *Naylor and Siedow*

**265. Physiological Plant Ecology.** The physiological approach to interpreting adaptation in plants, with emphasis on terrestrial seed plants. Prerequisites: Botany 146L and 151L or equivalent. One course. *Strain*

**265L. Physiological Plant Ecology.** See Botany 265. Lectures and laboratories. One course. *Strain*

**267L. Plant Community Ecology.** Concepts and methods of plant synecology. Introduction to the plant communities of North Carolina. Prerequisites: Botany 142L and 146L or equivalent, and consent of instructor. One course. *Christensen*

**285S. Population Genetics.** A seminar and lecture course devoted to the analysis of the current literature in population genetics. Prerequisites: genetics or Botany 280 or equivalent and consent of instructor. (Also listed as Genetics 285.) One course. *Antonovics*

**287S. Quantitative Genetics.** Analysis of genetic variation in continuous traits. Models of continuous variation; genetic, environmental, and interaction components; genetic correlation; heritability estimation; selection response. Prerequisites: Botany 180 or equivalent and consent of instructor. One course. *Antonovics*

**295S, 296S. Seminar.** Credit to be arranged. *Staff*

## MARINE LABORATORY

Botany 211L and 214L are offered during the summer at the Duke University Marine Laboratory, Beaufort, North Carolina. The Department of Botany also participates in the spring semester program at the Marine Laboratory. Consult the *Bulletin of the Marine Laboratory* for further information.

## THE UNIVERSITY PROGRAM IN GENETICS

Courses offered by the Botany Department are an integral part of this interdepartmental program. Refer to the announcement in this *Bulletin* under Genetics, the University Program for descriptions of the other offerings.

## DEPARTMENTAL MAJOR

### For the A.B. Degree

This degree program is the general liberal arts major program. Pre-professional students should elect the bachelor of science degree program.

**Prerequisites.** Introductory college biology or advanced placement in botany; two semesters of introductory chemistry (Chemistry 11-12) or advanced placement in chemistry; one semester of college mathematics or equivalent.

**Major Requirements.** A minimum of eight approved science courses in addition to prerequisites: at least five courses to be selected from the following: Botany 135L (Evolutionary Systematics) or 142L (Systematics), 145L (Plant Diversity), 146L (Plant Ecology), 151L (Plant Physiology), 160L (Plant Anatomy), and 180 (Principles of Genetics). With the approval of the Director of Undergraduate Studies, one or two of the remaining science courses may be taken in a related department. Students' programs will be tailored to their interests and plans for the future.



## For the B.S. Degree

This degree program is particularly recommended for all pre-professional students.

*Prerequisites.* Introductory college biology or advanced placement in botany; chemistry through organic; two terms of college mathematics or equivalent.

*Major Requirements.* Eight science courses as described under major requirements for the A.B. degree. A proficiency in reading German, which may be demonstrated by a *B* in German 181-182, or by passing either the FLETS or departmental German examination. One year of college physics or equivalent and a course in statistics are recommended. The emphasis in this pre-professional program will depend on the student's interests, and each program will be arranged on an individual basis.

## Interdepartmental Concentration

An interdepartmental program (e.g., in cell and molecular biology, physical biology, and marine biology) may be pursued instead of a departmental major. The appropriate director of undergraduate studies in botany or zoology will arrange administrative responsibility for such programs.

## Honors

The department offers a program for graduation with distinction in botany. (See the section on Honors in this *Bulletin* for general requirements.) The program is usually initiated during the junior year and involves participation in at least two semesters of independent study (Botany 191, 192). The research paper which results from this experience is submitted to a departmental committee for review, followed by a discussion of the paper with the student. On the basis of the quality of the research report and the student's performance in the discussion of it, the committee may recommend the student for graduation with distinction in botany.

## Canadian Studies Program

Professor Preston, *Director and Chairman of the Canadian Studies Committee*

The major and program in Canadian studies are designed to provide the student with an understanding of Canada and its problems and prospects.

### Major in Canadian Studies

1. A student wishing to pursue a major in Canadian studies must simultaneously follow another major to completion.

2. The prerequisites or corequisites required for the Canadian studies major are those required for the study of the student's other major.

3. Eight courses in the Canadian Studies Program must be taken for the major. The eight courses must include the Interdisciplinary Course 184 and two other courses on Canada with full or partial content at the 200-level, or seminars, or special reading courses as approved by the Committee of Canadian Studies. No more than six of the courses listed below under Courses with Substantial Canadian Content may be included as half-courses to make up the eight required courses. No more than two courses required for the first major may be counted for the Canadian studies major.

4. To complete the major in Canadian studies a student must have also taken at least two full years of college-level French, or must possess an equivalent competence in the language as certified by the Department of Romance Languages.

## Program in Canadian Studies

In the Canadian Studies Program, completion of which is imprinted on the official record upon graduation, a student must take four courses with Canadian content or their equivalents (see below). These must include the interdisciplinary course, *Canada: Problems and Issues of an Advanced Industrial State*. It is recommended that students who do not have the equivalent of two years of college-level French should take French 181-182, Intensive French.

The program in Canadian studies may be taken as part of a major in history or political science, as a supplement to any other major, as part of an interdepartmental concentration, or or under Program II.

## Courses in Canadian Studies

For a description of the courses consult listings under Interdisciplinary Courses and the specified departments.

**Courses with Full Canadian Content.** The following courses count as one full course in the four required for the Program in Canadian Studies and the eight required for the major in Canadian Studies:

Economics 52. *Competition, Monopoly, and Welfare. Tower\**

Economics 116S. *Economic Geography of Anglo-America. Tuthill*

English 167. *The Literature of English-Speaking Canada. Armitage*

French 125. *The French of Canada. Hull*

History 183S. *Canada from the French Settlement. Preston*

History 187. *Canada and the United States: Their Diplomatic Relations. Davis*

Interdisciplinary 184. *Canada: Problems and Issues of an Advanced Industrial State.* (Also listed under economics, history, political science, and sociology.) *Preston, Duke Faculty, and Visiting Lecturers*

Political Science 110. *The Canadian Polity. Mishler*

Political Science 195. *Comparative Political Behavior in the United States and Canada. Kornberg*

Political Science 278. *Canadian Political Behavior in the North American Context. Kornberg*

**Courses with Significant Canadian Content.** Two of these may count as one course among the four courses required for the program in Canadian Studies and the eight courses required for the major in Canadian Studies.

Anthropology 117. *Language, Law, and Politics.* By special consent this course may be counted as a full Canadian content course. *O'Barr*

Anthropology 278S. *Special Topics in Political Anthropology: Language and Law. O'Barr*

Anthropology 281S. *Special Topics in Anthropology: Comparative Ethnicity. Fox*

Anthropology 281S. *Special Topics in Anthropology: Language and Politics. O'Barr*

Economics 115. *Fundamentals of Geography. Tuthill*

Economics 201S.1. *Current Issues in Economics. Davies*

Economics 265S. *International Trade and Finance. Tower*

History 297S. *The British Empire in the Nineteenth Century. Preston*

History 298S. *The Commonwealth in the Twentieth Century. Preston*

Political Science 135S. *Comparative Legislative Behavior. Mishler*

Political Science 252S. *Comparative Political Behavior and Socialization. Mishler*

Sociology 142. *The Sociology of Mass Communication. Smith*

Sociology 145. *Urban Sociology. Smith*

A limited amount of financial aid for field work in Canada is available for undergraduates in the Canadian Studies Program.

## Chemistry

Professor Krigbaum, *Chairman*; Professor Poirier, *Director of Undergraduate Studies*; Professor Bonk, *Supervisor of Freshman Instruction*; Professors Bradsher, Chesnut, Hobbs, Jeffs, McPhail, Quin, Smith, Strobel, Wells, and Wilder; Visiting

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\*Full Canadian content is given to Dr. Tower's section only.

Professor Dawson; Associate Professors Baldwin, Crumbliss, Henkens, Lockmüller, Palmer, and Porter; Adjunct Associate Professors Ghirardelli, Pitt, Rosenthal, and Spielvogel; Assistant Professors Baier, Gutknecht, Luken, Neilson, and Shaw;

The *M* suffix on some first- and second-year courses denotes an enriched course presented in a more interactive format made possible by a marked reduction in class size. The required consent of instructor depends on the ability, preparation, and academic goal of the student. All curricular requirements may be satisfied by either *M* courses or courses lacking this suffix; the *M* suffix will not appear on the transcript.

**10. Introductory Chemistry.** Emphasis on the mathematical aspects of chemistry and topics such as structure and bonding. Closed to students having credit for Chemistry 11. Designed for students needing further preparation before taking Chemistry 11, 12. Prerequisite: Mathematics 19 or the equivalent. One course. *Staff*

**11, 12. Principles of Chemistry.** The introductory course for students who intend to take any additional chemistry courses other than Chemistry 103. Chemistry 11 emphasizes stoichiometry and atomic and molecular structures. Chemistry 12 emphasizes thermodynamics, chemical kinetics, synthesis, and analysis. Laboratory work includes both qualitative and quantitative analysis. Two lectures, one recitation, and one four-hour laboratory. Prerequisites: one year of high school chemistry or Chemistry 10, and qualification for Mathematics 31. Two courses. *Bonk and Staff*

**103. Chemistry and Society.** Past discoveries and current challenges: a chemical background for decisions involving energy, radiation, pollution, drugs, food additives, vitamins, and pesticides. For students not majoring in a natural science or continuing in chemistry. Not open to students having credit for Chemistry 11 or equivalent, except by consent of instructor. One course. *Staff*

**117. Inorganic Chemistry.** Bonding, structures, and reactions of inorganic compounds studied through physical chemical concepts. Three lectures. Prerequisite: Chemistry 161. One course. *Crumbliss, Neilson, Palmer, or Wells*

**132. Quantitative and Instrumental Analysis.** Practice in advanced quantitative analysis and in the use of chemical instrumentation. Theoretical and applied aspects of chemical and instrumental methods. Three lectures and four and one-half laboratory hours. Prerequisite: Chemistry 161. One course. *Gutknecht, Lochmuller, or Strobel*

**151, 152. Organic Chemistry.** The structures and reactions of the compounds of carbon. First semester laboratory: techniques of separation and structure determination. Second semester: organic reactions and preparations. Three lectures and four laboratory hours. Prerequisite: Chemistry 12 or consent of the Director of Undergraduate Studies; Chemistry 151 or 151M is a prerequisite for 152. Two courses. *Baldwin, Bradsher, Jeffs, Porter, Quin, and Wilder*

**151M, 152M. Organic Chemistry.** Paralleling Chemistry 151 and 152, but stressing topics of importance for those who expect to major in chemistry. Three lectures and four laboratory hours. Prerequisites: Chemistry 12 and consent of instructor; Chemistry 151 or 151M is a prerequisite for 152M. Two courses. *Staff*

**152P. Preceptorial.** Preceptorial elective for students in Chemistry 152M. Prerequisites: Chemistry 151M or consent of instructor. *Staff*

**155. Spectral and Structural Study of Organic Compounds.** Advanced study of spectral properties and structural aspects of organic compounds and the influence of structure on reactivity. Laboratory work emphasizes the systematic identifica-

tion of compounds by their spectral aspects and by their chemical properties. Three lectures and four and one-half laboratory hours. Prerequisite: Chemistry 152 or 152M. One course. *Porter and Quin*

**161, 162. Physical Chemistry.** Fundamentals of theoretical chemistry illustrated by selected laboratory experiments. Two lectures, one recitation, and four laboratory hours. Prerequisites for 161: Chemistry 152 or 152M, Physics 51, 52, and Mathematics 32. Prerequisites for 162: Chemistry 161 and either Mathematics 103 or consent of instructor. Two courses. *Chesnut, Henkens, Hobbs, Krigbaum, Luken, McPhail, Poirier, and Smith*

**175. Molecular Basis of Biological Processes.** A survey of the structures, reactions, and mechanisms of action of important biological molecules. Prerequisite: Chemistry 152 or 152M. One course. *Shaw*

**191, 192. Independent Study.** Supervised reading and research. Prerequisite: consent of the department. Two courses. *Staff*

**193, 194. Independent Study.** Supervised reading and research. Prerequisites: Chemistry 191, 192, and consent of the department. Two courses. *Staff*

**195S. Seminar.** Organic chemistry of biologically important compounds. Open to senior chemistry majors, or by consent of instructor. One course. *Baldwin*

**196S. Seminar.** Selected topics in physical chemistry of biological macromolecules. Prerequisites: Chemistry 161 and 175. One course. *Henkens*

**197S. Seminar.** Special topics in biological chemistry (e.g., immunochemistry, molecular biology). Prerequisite: Chemistry 161; Chemistry 175 is recommended. One course. *Staff*

**198S. Seminar.** Topics from various areas of chemistry, changing each semester. Open to senior chemistry majors or by consent of the Director of Undergraduate Studies. One course. *Staff*

### For Seniors and Graduates

**201. Molecular Spectroscopy.** Selected spectroscopic methods in the study of molecular structure. Symmetry and group theoretical basis for selection rules, theories of magnetic and optical resonance, and interpretation of spectra; examples from both inorganic and organic chemistry. Three lectures. Prerequisite: consent of department. One course. *Staff*

**203. Quantum Chemistry.** Basic principles of quantum and group theoretical methods. Topics include symmetry, a review of the fundamentals and the mathematical foundation of quantum theory. Emphasis on the application of molecular orbital theory to organic and inorganic systems. Three lectures. Prerequisite: consent of department. One course. *Staff*

**205. Structure and Reaction Dynamics.** Structure and mechanisms in organic and inorganic compounds, substitution reactions, linear free energy relations, and molecular rearrangements. Emphasis on the use of kinetic techniques to solve problems in reaction mechanisms. Three lectures. Prerequisite: consent of department. One course. *Staff*

**207. Principles of Thermodynamics, Diffraction, and Kinetics.** Three lectures. Prerequisite: consent of department. One course. *Staff*

**230. Environmental Oceanography.** Chemical, biological, and geological aspects of pollution in the marine environment. Anthropogenic effects upon natural



marine processes on shore lines and shelves. Application of marine science to compatible utilization of marine resources. Prerequisite: consent of instructor; physical chemistry is recommended. (Also listed under Marine Sciences.) Given at Beaufort. One and one-half courses. *Baier and Staff*

**240. Chemical Oceanography.** Distribution, alteration, and transport of chemical species in the marine environment. Field cruises to gather samples for evaluating chemical processes in the ocean. Lectures, laboratory work, and field trips. Prerequisite: consent of instructor; physical chemistry is recommended. (Also listed under Marine Sciences.) Given at Beaufort. One and one-half courses. *Baier and Staff*

**275, 276. Advanced Studies.** (1) Analytical chemistry; (2) inorganic chemistry; (3) organic chemistry; and (4) physical chemistry. Open to especially well-prepared undergraduates by consent of department. Two courses. *Staff*

## DEPARTMENTAL MAJOR

Two different baccalaureate degrees are offered. The A.B. degree permits greater flexibility in allowing students to select an area of concentration while satisfying the junior-senior small group learning experience requirements through seminar courses (option one) or through independent study in chemistry or related departments (option two). Of special significance is the area of biological chemistry; under the direction of the Biological Chemistry Program Coordinator, students may specialize in this area with either seminars (option three) or independent study in chemistry or related departments (option four) satisfying the junior-senior small group learning experience requirement. The B.S. degree program requires independent study and provides in-depth preparation for graduate study in chemistry.

### For the A.B. Degree

*Prerequisites.* Chemistry 11 and 12 or advanced placement; Mathematics 31, 32; Physics 51, 52.

*Major Requirements.* Chemistry 132, 151, 152, 161, *plus* one of the following options:

1. Two of the following: Chemistry 117, 155, 162, 175, 195S, 196S, 197S, 198S.

2. One of the following: Chemistry 117, 155, 162; *plus* Chemistry 191 and 192, or the equivalent in a natural science, in mathematics, engineering, or in a basic science department in the School of Medicine.

3. Chemistry 175, 195S or 197S, and 196S.

4. Chemistry 175, 196S; and Chemistry 191 and 192 in a biochemically related area, or the equivalent in a biological area, biomedical engineering, or basic science department in the School of Medicine.

*Recommended.* Computer Science 51, Mathematics 103 (for options 1 and 2); Chemistry 162 (for options 3 and 4); two semesters of a foreign language or the equivalent. Students planning graduate study are advised to take these recommended courses and to consult with advisers regarding appropriate additional courses.

### For the B.S. Degree

*Prerequisites.* Chemistry 11 and 12 or advanced placement; Mathematics 31, 32, 103; Physics 51, 52; two semesters of German or Russian, or the equivalent.

*Major Requirements.* Chemistry 117, 132, 151, 152, 155, 161, 162, 191, 192, and 203 or 207.

*Recommended.* Computer Science 51; Mathematics 104; Physics 161. Students planning graduate study in chemistry should consult with advisers regarding appropriate additional courses.

## Classical Studies

Professor Oates, *Chairman*; Assistant Professor Burian, *Director of Undergraduate Studies*; Professors Newton, Richardson, and Willis; Associate Professor Stanley; Assistant Professors Rigsby and Younger; Instructor Raschke; Lecturer Levy

### GREEK

**1-2. Elementary Greek.** A study of grammar and an introduction to reading. Two courses. *Willis and Staff*

**63-64. Intermediate Greek.** Introduction to Greek prose and poetry. First semester: Plato's *Apology of Socrates* and two dialogues. Second semester: two plays of Euripides. Two courses. *Burian and Staff*

**87, 88. Sight Reading in Greek Prose.** Readings from easy Attic prose writers. Prerequisite: one year of college Greek, or the equivalent, and consent of instructor. Two hours per week. Two half-courses. *Willis*

**117. Greek Prose Composition.** The character of the course is determined by the needs of the students enrolled. Half-course. *Willis*

**151S. Homer.** One course. *Stanley*

**152S. Lyric Poets.** One course. *Stanley*

**153S. Tragedy.** One course. *Burian*

**154S. Comedy.** One course. *Burian*

**155S. The Historians.** One course. *Rigsby*

**156S. The Orators.** One course. *Burian*

**181S, 182S. Greek Seminar.** An intensive introduction to the language and literature. Meets five times a week. Prerequisite: proficiency in another language. Two courses each. *Staff*

**191, 192. Independent Study.** Directed reading and research. (Open only to qualified juniors and seniors.) Two courses. *Staff*

**193, 194. Directed Research in Greek.** Research culminating in the writing of one longer or two shorter papers as partial fulfillment of the requirements for graduation with distinction. (Open only to senior majors.) Two courses. *Staff*

**198S, 199S. Senior Seminar in Greek.** The seminar will change according to the interests of the instructor. Two courses. *Staff*

### For Seniors and Graduates

**200. Graduate Reading.** (Open to qualified undergraduates by consent of instructor.) One course. *Staff*

**203. Homer.** The *Iliad* and *Odyssey*; the problems of language and structure in the epic; present state of Homeric scholarship. One course. *Levy or Stanley*

**205. Greek Lyric Poets.** Fragments of the early lyric poets; selected odes of Pindar and Bacchylides. One course. *Burian or Stanley*

**206. Aeschylus.** The *Oresteia*, with study of the form of *Agamemnon* and its place in the design of the trilogy. One course. *Willis*

**208. Sophocles.** The Theban plays; the structure and style of Sophoclean tragedy. One course. *Stanley or Burian*

**209. Euripides.** Representative tragedies in their political and philosophical context; analysis of dramatic form and texture. One course. *Stanley*

**210. Aristophanes.** Origin and development of Greek comedy; representative plays of Aristophanes. One course. *Burian*

**221. Early Greek Prose.** Greek prose in the fifth century from the Ionian scientists and logographers to Herodotus, Gorgias, Antiphon, and the Old Oligarch. One course. *Willis*

**222. Thucydides.** The *History*; Thucydides' historical method and style. One course. *Willis*

**223. Greek Orators I.** Early fourth-century rhetoric, including Andocides, Lysias, and Isocrates. One course. *Burian*

**224. Greek Orators II.** Aeschines' *Against Ctesiphon* and Demosthenes' *On the Crown* in the light of fourth-century political history and rhetorical development. One course. *Willis*

**225. Plato.** Selected dialogues and related passages illustrating the development of philosophical topics and stylistic motifs. One course. *Stanley*

**231. Hellenistic Poetry.** The principal lyric, elegiac, pastoral, and didactic poets of Alexandria; emphasis on Callimachus and Theocritus. One course. *Stanley*

## LATIN

**1-2. Elementary Latin.** Study of the structure of the language (inflexions, vocabulary, syntax, and pronunciation). Second semester: reading in prose and poetry. Two courses. *Newton*

**63. Intermediate Latin.** Selected prose. One course. *Newton*

**64. Intermediate Latin: Vergil.** Readings from the *Aeneid*; lectures on the epic and its history and Vergil's style and technique. One course. *Newton*

**87, 88. Sight Reading in Classical, Medieval, and Renaissance Latin.** Offered especially for students in fields other than classical studies who wish to maintain and refresh their Latin. Two hours per week. (Open to students enrolled in other courses in Latin only on the recommendation of their instructors.) Two half-courses. *Staff*

**100.** This number represents one course credit for advanced placement which will be awarded for scores of 4 or 5 on one or more of the College Board Advanced Placement tests in Latin. One course credit may be earned by a score of 3 if the student successfully completes one further semester of Latin.

**105S. Ovid.** One course. *Newton*

**107S. Lyric Poets.** One course. *Richardson*

**111S. Elegaic Poets.** One course. *Richardson*

112S. **Comedy.** One course. *Richardson*

117. **Latin Prose Composition.** The course content is determined by the needs of the students enrolled. One course. *Staff*

133. **Early Greece and the Near East.** Political, social, and intellectual developments from the world of Homer to the Persian Wars. One course. *Oates*

151S. **Cicero.** One course. *Richardson*

152S. **The Historians.** One course. *Rigsby*

153S. **Petronius.** One course. *Richardson*

154S. **Lucretius.** One course. *Richardson*

181S, 182S. **Latin Seminar.** An intensive introduction to the language and literature. Meets five times a week. Open only to students who have achieved proficiency in another language. Two courses each. *Staff*

191, 192. **Independent Study.** Directed reading and research. Open to qualified juniors and seniors. Two courses. *Staff*

193, 194. **Directed Research in Latin.** Research culminating in the writing of one longer or two shorter papers as partial fulfillment of the requirements for graduation with distinction. Open only to senior majors. Two courses. *Staff*

198S, 199S. **Senior Seminar in Latin.** The seminar will change according to the interests of the instructor. Two courses. *Staff*

### For Seniors and Graduates

200. **Graduate Reading.** Open to qualified undergraduates by consent of instructor. One course. *Newton or Stanley*

201. **The Verse Treatise.** The genre of didactic poetry; emphasis on Lucretius' *De Rerum Natura*, Vergil's *Georgics*, and Ovid's *Ars Amatoria*; attention to Cicero's *Aratea*, the *Astronomica* of Manilius, Horace's *Ars Poetica*, and Ovid's *Fasti*. One course. *Newton or Richardson*

202. **Roman Satire.** A survey of the genre with concentration on Horace, Juvenal, and Persius. One course. *Richardson*

203. **Epic: Vergil.** The *Aeneid*. One course. *Newton*

204. **Epic: Lucan and Statius.** The development of the Roman epic in the Silver Age. One course. *Richardson*

209. **Fragments of Early Latin.** The remains of Latin poetry of the third and second centuries B.C., from Livius Andronicus to Lucilius, with emphasis on the epic and drama of Ennius. One course. *Stanley*

210. **Lyric and Occasional Poetry.** Shorter verse forms: epigram, pastoral, song, and panegyric. One course. *Staff*

211. **Roman Oratory I.** The literary history and criticism of Roman oratory. One course. *Richardson*

212. **Roman Oratory II.** A continuation of Latin 211. One course. *Staff*

221. **Medieval Latin I.** Latin literature of late antiquity, from Prudentius to the Carolingian Revival. One course. *Newton*



**222. Medieval Latin II.** Literature in Latin from Charlemagne to the Renaissance. One course. *Newton*

**250. Teaching Latin.** Objectives, methods, and problems; the study of textbooks, programs, and related materials. One course. *Staff*

## CLASSICAL STUDIES

**11. Greek Civilization.** The culture of the ancient Greeks from the Bronze Age to Alexander the Great: art, literature, history, philosophy, and religion. One course. *Rigsby*

**12. Roman Civilization.** The culture of the ancient Romans from their beginnings to Constantine: art, literature, history, philosophy, and religion. One course. *Rigsby*

**51. Greek Literature in English Translation.** Reading in translation of major Greek authors, with emphasis on the Homeric epic and the Attic drama. One course. *Burian*

**52. Latin Literature in English Translation.** Reading in translation of major Roman authors, such as Plautus, Terence, Vergil, Horace, Ovid, Petronius, Juvenal, Tacitus, and Apuleius. One course. *Burian*

**53. Greek History.** The political and intellectual history of the Hellenes from earliest times to the death of Alexander the Great. (Also listed as History 52.) One course. *Raschke*

**54. Roman History.** The Roman Republic and Empire to the Council of Nicaea. (Also listed as History 54.) One course. *Raschke*

**55. Greek Art and Archeology.** Greek architecture, sculpture, and painting from the Bronze Age to the classical period. Study of objects in the Duke Classical Collection is included. One course. *Younger*

**56. Roman Art and Archeology.** Rome's achievement in architecture and decoration, portraiture, and relief sculpture; from the Villanovans to the Antonine emperors. One course. *Younger*

**57S, 58S. Seminar in Classical Studies.** Aspects of the history, art, and literature of classical Greece and Rome. For freshmen and sophomores. Two courses. *Staff*

**114. Greek Drama.** Readings in English translation of Aeschylus, Sophocles, Euripides, Aristophanes, and Menander. One course. *Burian or Rigsby*

**115. The Classical Tradition.** The notion of the "classical" from the creation of the archetype to the present. One course. *Burian or Rigsby*

**116. Greek Literature of the Roman Empire.** The intellectual world of late antiquity; readings in translation of pagan and early Christian writers. One course. *Rigsby*

**117. Ancient Mythographers.** Myth in classical and medieval writers from Hesiod to Boccaccio. One course. *Newton*

**133. Early Greece and the Near East.** Political, social, and intellectual developments from the world of Homer to the Persian Wars. (Also listed as History 96.) One course. *Oates*

**134. The Athenian Empire.** Imperial democracy at Athens and its consequences for the *polis*. (Also listed as History 125.) One course. *Oates*

**135. Alexander the Great.** His career and the effects of his conquests. (Also listed as History 126.) One course. *Oates*

**137. The Roman Revolution.** Rome from the time of the Gracchi to the death of Augustus (14 A.D.). (Also listed as History 95.) One course. *Oates*

**138. The Decline and Fall of Rome.** Rome from the death of Commodus to the accession of Constantine. One course. *Oates*

**143. The Ancient Cities of Greece.** The *polis* as a physical and societal complex; urban problems and their solutions through the centuries. A different Greek city that has been extensively excavated and well published is chosen as representative of each century and examined in detail. One course. *Richardson*

**144. Ancient Cities: Rome and Her Colonies.** As a metropolis and a cosmopolis; the sources and uses of significant architectural and urbanistic ideas; the city government and organization of the megalopolis; Roman colonies throughout the Empire. One course. *Richardson*

**155. The Aegean Bronze Age.** Application of archeological techniques and procedures to problems in the development of the Minoan and Mycenaean civilizations. One course. *Younger*

**156. Principles of Archeology.** Ethics, techniques, and methods of archeological research, including excavation and surveying of local sites. One course. *Younger*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified juniors and seniors. Two courses. *Staff*

**193, 194. Directed Research in Classical Studies.** Research culminating in the writing of one longer or two shorter papers as partial fulfillment of the requirements for graduation with distinction. Open only to senior majors. Two courses. *Staff*

**195S, 196S. Junior Seminar in Classical Studies.** The seminar will change each year according to the interest of the instructor. Two courses. *Staff*

#### **For Seniors and Graduates**

**231S. Greek Sculpture.** One course. *Stanley*

**232S. Greek Painting.** One course. *Stanley*

**235S. Roman Architecture.** One course. *Richardson*

**236S. Roman Painting.** One course. *Richardson*

**253. Greece to the Orientalizing Period.** One course. *Rigsby*

**254. The Age of the Tyrants and the Persian Wars.** One course. *Oates*

**255. The Age of Pericles.** One course. *Oates*

**256. The Fourth Century through Alexander.** One course. *Oates*

**257. Social and Cultural History of the Hellenistic World from Alexander to Augustus.** One course. *Rigsby*

**261. The Roman Revolution, 146-30 B.C.** One course. *Oates*

262. Rome under the Julio-Claudians. One course. *Raschke*

263. From the Flavian Dynasty to the Severan. One course. *Raschke*

## DEPARTMENTAL MAJOR IN GREEK

*Prerequisite.* Greek 2 or equivalent.

*Major Requirements.* Six courses in Greek above the level of Greek 2. In addition, students will be required to pass an examination testing proficiency in Greek composition or to complete Greek 117.

*Related Work.* Greek majors normally take at least four semesters of Latin and are also encouraged to take course work in ancient history and/or archeology. The nature and amount of related work, however, may vary with the student.

## DEPARTMENTAL MAJOR IN LATIN

*Prerequisite.* Latin 64 or equivalent.

*Major Requirements.* Six courses in Latin above the level of Latin 64. In addition, students will be required to pass an examination testing proficiency in Latin composition or to complete Latin 117.

*Related Work.* Latin majors normally take at least four semesters of Greek and are also encouraged to take course work in ancient history and/or archeology. The nature and amount of related work, however, may vary with the student.

## DEPARTMENTAL MAJOR IN CLASSICAL STUDIES (ANCIENT HISTORY AND ARCHEOLOGY)

*Prerequisites.* Classical Studies 11D, 12D; 51, 52; 53, 54; 55, 56; or 57S, 58S.

*Major Requirements.* Eight courses at the 100-level or above, including two courses of seminar or independent study, or a combination of these. Reading knowledge of Latin or Greek to the level of Latin 64 or Greek 64. Two courses in the ancient languages above that level may be counted toward the major.

Majors in either Greek or Latin who contemplate graduate work are reminded of the necessity for competence in both languages for all higher degrees and of the requirement for a reading knowledge of French and German.

Majors are eligible for nomination to a term of one semester during their junior year at the Intercollegiate Center for Classical Studies in Rome, of which Duke University is a founding member, at a cost comparable to that of a semester at Duke. Financial arrangements are made through the University, and students may apply for scholarship assistance. Courses in Greek, Latin, ancient history, and archeology taken at the center are counted toward the major requirements. For further information, see section on Study Abroad.

The department offers work leading to graduation with distinction. See the section on Honors in this *Bulletin*.

## Comparative Area Studies

Associate Professor Valenzuela, *Director*

The undergraduate major in Comparative Area Studies offers a Bachelor of Arts degree to students interested in the interdisciplinary study of societies and cultures of a particular region of the world, while at the same time concentrating in an academic discipline. Students in the program are currently studying Latin America, Africa, the Middle East, Russia, South Asia, and East Asia. The major draws its offerings from existing courses taught by over forty Duke professors in a

dozen cooperating departments. In addition to its Director, the program is administered by an advisory committee of faculty members representing the various areas and cooperating departments. Inquiries may be directed to Professor Valenzuela, 320 Perkins.

## THE MAJOR

In consultation with the Director, students must identify their primary disciplinary and area focus. A student wishing to specialize in an area not indicated in the categories of courses that follow will be required to submit a proposed course of study to the advisory committee for approval. Selection of area and discipline is normally done by the end of the sophomore year.

A special feature of the major is provision for granting credit to students who wish, and who are qualified, to study abroad in the area of choice; or who undertake intensive summer language programs in the United States.

*Prerequisites.* Any two of the following introductory-level courses emphasizing comparative approaches: History 175, 176 (Introduction to Asia, Africa, and Latin America); Anthropology 94 (Elements of Cultural Anthropology); or Anthropology 99 (Cultural Anthropology for social science majors), but not both 94 and 99; Religion 57 (Introduction to Religions of Asia); Political Science 92 (Comparative Politics). Four semester-courses of which two shall be in a language of the area, and the other two may be a continuation of the language or two of the following: literature of the area in translation, or general linguistics. The Director should be consulted for specific approval of language choice.

*Major Requirements.* Discipline courses: four semester-courses in a discipline (either social science or humanities). Area courses: four semester-courses in the geographic area of special interest, and two in another one of the areas included in the major. Seminar: in the senior year, one-semester interdisciplinary seminar, bringing together a number of major themes for comparative treatment.

The courses listed below may be taken for credit as area courses. Others may be selected with the approval of the Director. Courses in language instruction are not included in this list. For a complete description consult the listing under the appropriate department.

## AFRICA

Anthropology 125 (Peoples of the World: Africa); 134 (Political Anthropology); 222S (Topics in African Anthropology).

Black Studies 113 (African Philosophy); 150 (Third World Literature).

Economics 114 (Economic Geography of Africa); 214 (Geonomics: Geography and Contemporary Economics of Africa); 219 (Economic Problems of Underdeveloped Areas).

History 115-116 (History of Africa); 117-118 (European Imperialism and Colonialism); 195Y-196Y (Issues in the History of Tropical Africa); 255S-256S (Problems in African History).

Political Science 161 (Comparative Government and Politics: Africa); 163 (Women in Developing Societies); 171 (Race, Class, and Colonialism in Southern Africa); 280 (Comparative Government and Politics: Sub-Saharan Africa).

Religion 113 (African Philosophy); 289 (World Religions and Social Change).

Sociology 136 (Sociology of Modern Africa).

## EAST ASIA

Chinese 135, 136 (Introduction to Modern Chinese Literature); 141 (Chinese Literature in Translation).



Economics 120 (Economic Geography of Asia); 201S.9 (The Japanese Economy); 232 (Economic History of Japan).

History 141 (Man and Society in Traditional China); 142 (China: The Roots of Revolution); 143-144 (History of Modern Japan); 177 (China since 1949: The People's Republic); 195-196G (Nationalism and Communism in the Far East); 195S-196S (Processes of Development in Modern Japan: 1800 to the Present); 260 (Economic History of Japan).

Japanese 155-156 (Introduction to Modern Japanese Literature); 161 (Modern Japanese Fiction in Translation).

Political Science 168 (Political Development in East Asia); 169 (Politics in Revolutionary China); 111 (Contemporary Japanese Politics); 149 (America in East Asia); 212 (Japanese Foreign Policy).

Religion 141 (Religions of China and Japan); 149 (Buddha and Buddhism); 283 (Religions of East Asia).

## LATIN AMERICA

Anthropology 124 (Peoples of the World: American Indian).

Art 149 (Pre-Columbian Art and Archeology); 150 (Latin American Art); 249 (Problems in Pre-Columbian Art and Archeology); 250 (Problems in Latin American Art).

History 128 (The United States and Latin America); 131 (Mexico and the Caribbean from the Wars of Independence to the Present); 132 (Major South American Nations: 1850 to the Present); 155-156 (Modern Latin America); 173, 174 (History of Spain and the Spanish Empire from Late Medieval Times to the Present); 195X-196X (Problems in Latin American History); 265S-266S (Problems in Modern Latin American History).

Political Science 151 (Introduction to Latin American Politics); 152 (Authoritarianism and Revolution in Latin America); 253 (Comparative Politics and the Study of Latin America).

Spanish 107, 108 (Introduction to Spanish American Literature and Civilization); Spanish 155 (Spanish American Short Fiction); 157 (Latin American Literature in Translation); 158 (Spanish American Colonial and Nineteenth-Century Literature); 255-256 (Modern and Contemporary Latin American Literature).

Sociology 254 (Urbanization and Social Change).

## MIDDLE EAST

Anthropology 129 (Peoples of the World: Middle East).

History 188 (Middle East: 1789 to the Present).

Religion 57 (Introduction to Religions of Asia); 136 (Contemporary Jewish Thought); 147 (Mohammed and the Qur' ān); 284 (The Religion and History of Islam).

## RUSSIA

Economics 293 (Soviet Economic History); 294S (Soviet Economic System).

History 119-120 (History of Socialism and Communism); 161-162 (History of Modern Russia); 201S-202S (Change in Prerevolutionary Russia); 261-262 (Problems in Soviet History); 195J-196J (History of International Socialism to the First World War); 195T-196T (Problems in the History of Russia before 1917).

Political Science 117 (Comparative Legal Systems); 162 (Comparative Government and Politics: Communist and Socialist Political Systems); 165 (Government and Politics of the Soviet Union); 166 (Soviet Foreign Relations).

Slavic Languages and Literature 101-102 (Russian Literature and Culture Through the Nineteenth Century); 124 (Masters of Russian Short Fiction); 174 (The Poles: Literature and Culture, 1940-1970); 188 (Solzhenitsyn and the World of Soviet Concentration Camps); 201-202 (The Novelists of Nineteenth-Century Russia); 207 (Soviet Literature and Culture).

## SOUTH ASIA

Anthropology 101-102 (Introduction to the Civilization of Southern Asia); 134 (Political Anthropology); 141 (Peoples of the World: Southeast Asia); 142 (Peoples of the World; South Asia); 220 (Society and Culture in India).

Hindu-Urdu 171-172 (Studies in Indian Literatures); 173-174 (Literature and Revolution).

Economics 120 (Economic Geography of Asia).

Education 218 (Comparative and International Education: Developing Societies); 219 (Comparative and International Education: South Asia).

History 193-194 (Introduction to the Civilizations of Southern Asia); 147 (History of India to 1707); 148 (History of India and Pakistan to the Present); 195W (Studies in Modern Indian History); 248 (History of Modern India and Pakistan, 1857 to the Present); 297S (The British Empire in the Nineteenth Century); 298S (The Commonwealth in the Twentieth Century).

Political Science 101-102 (Introduction to the Civilization of Southern Asia); 148 (Arab and Non-Arab Muslim World); 155 (Problems of Political Development in the New States); 180 (Comparative Government and Politics: Southern Asia I); 181 (Comparative Government and Politics: Southern Asia II); 250 (Comparative Government and Politics: Southern Asia).

Religion 140 (Religions of India); 148 (Introduction to the Civilization of Southern Asia); 149 (Buddha and Buddhism); 217 (Islam in India); 284 (The Religion and History of Islam); 285 (The Vedic Tradition: Compilation and Interpretation); 286 (Religious Trends in Modern India); 287 (Scriptures of Asia); 288 (Buddhist Thought and Practice).

## Comparative Literature

Professor Wardropper (Romance Languages), *Chairman of the Committee on Comparative Literature*; Professors Anderson (English), Newton (Classical Studies); Associate Professors Borchardt and Rolleston (Germanic Languages and Literature), Stewart (Romance Languages); Assistant Professor Hedges (Romance Languages)

Students contemplating a major in comparative literature should have a reading knowledge of a foreign language and a broad acquaintance with British and American authors. The program consists both of courses in literature written in a foreign language and of literature courses that are comparative in nature. Students taking the major are expected to acquire a reading knowledge of a second foreign language and to familiarize themselves with methods of studying literature in a comparative manner. The program, being largely interdisciplinary, is directed by a committee. All course selection requires the approval of the committee. Inquiries concerning eligibility and requirements should be directed to Professor Wardropper, Chairman of the Committee on Comparative Literature, 309 Language Building.

100. Introduction to **Comparative Literature**. History, prevailing approaches, methods of investigation, problems of literary influence and translation; European

and American movements and genres. Occasional guest lecturers. One course. *Rolleston*

**130. Urban Myths: Literature and Film.** The roots of modern urban myths and the generation of new forms in twentieth-century prose fiction and film from the interaction of the individual and the city. Eight novelists (including Rilke, Cortázar, Robbe-Grillet) and five directors (Eisenstein, Lang, Clair, Godard, Ozu). One course. *Hedges*

**170. The Modern: Problems of Definition, History, and Language.** Texts from about 1840 to the present studied with a view to defining "the modern" against the background of the romantic denial of transcendence and the turn to history, society, nature, and the self as sources of meaning. Baudelaire, Nietzsche, Dostoevsky, Proust, Kafka, Virginia Woolf, Borges. Other poetry and short fiction. One course. *Rolleston*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified students in the junior year, by consent of instructor. Two courses. *Staff*

**193, 194. Independent Study.** Directed readings and research. Open only to qualified students in the senior year, by consent of instructor. Two courses. *Staff*

### For Seniors and Graduates

**220S. Comparative Literature Seminar.** Topics vary. One course. *Jantz*

**280. Literary Criticism.** Emphasis on structuralist and post-structuralist theories and their antecedents. Lectures and discussion conducted by a interdepartmental team. One course. *Stewart*

## MAJOR IN COMPARATIVE LITERATURE

*Prerequisites.* A reading knowledge of at least one foreign language; English 55, 56 or the equivalent.

*Major Requirements.* (1) Comparative Literature 100; (2) two courses from those listed under Comparative Literature, or courses of literature in translation that cross national lines and invite comparative interpretation, or courses of literature written in languages that are seldom taught; (3) three courses in a single foreign literature at the 100-level or above, to be read in the original language; (4) acquisition of a second foreign language through at least the intermediate level.

This last requirement may be fulfilled by examination or by completion of such courses as the following: Greek 63-64 or 181, 182; Latin 1815, 1825; German 63, 101, or 181, 182; French 63, 74, or 181, 182; Italian 63, 74, or 181, 182; Russian 63-64; Hindi-Urdu 183-184; Japanese 153, 154.

The Committee on Comparative Literature will assist the major in creating a program having unity and direction and will advise the student of pertinent conference courses and seminars offered each year in the various literature departments.

## Computer Science

Professor Loveland, *Chairman*; Professor Gallie, *Director of Undergraduate Studies*; Professors Marinos, Naylor, and Woodbury; Associate Professors Hammond, Patrick, and Starmer; Adjunct Associate Professor Williams; Assistant Professors Biermann, Clarke, Foster, Gerhart, Ramm, and Trivedi

The Department of Computer Science provides courses on the concepts of

computing and computers, their capabilities and uses. Most courses require the student to make extensive use of one or more of the available computers as a problem-solving instrument. Students who wish to take a single introductory course in computer science, as part of their general education, usually elect Computer Science 51.

**42. Introduction to Digital Systems.** (Also listed as Electrical Engineering 42.) One course. *Marinos*

**51. Introduction to Digital Computation.** Flow charts; an assembly language; program structures, subroutines, data structures, arrays, polynomials; an algorithmic language; numerical linear algebra, matrix inversion, linear programming, and least-squares techniques. One course. *Gallie and Staff*

**100S. Computer Programming Techniques.** Advanced programming techniques and applications. Prerequisite: Computer Science 51. One course. *Gallie*

**150. Computers and Programming.** Computer structure, machine language, instruction execution, addressing techniques, and digital representation of data. Computer systems organization, logic design, micro-programming, and interpreters. Symbolic coding and assembly systems, macro-definition. Prerequisite: Computer Science 51 or equivalent with the consent of the Director of Undergraduate Studies. One course. *Staff*

**152. List Processing and Data Structures.** Linear lists such as stacks, queues, deques, circular lists, and doubly linked lists; trees; multilinked structures; dynamic storage allocation. Exercises may require use of an assembly language. Prerequisite: Computer Science 51 or equivalent with the consent of the Director of Undergraduate Studies. (Also listed as Mathematics 152.) One course. *Staff*

**157. Introduction to Switching Theory.** (Also listed as Electrical Engineering 157.) One course. *Marinos*

**163. Data Analysis.** Elements of probability and statistics, acquisition of data, maintenance of data bases, computation and display of statistical summaries. Prerequisites: Computer Science 51 and Mathematics 31 or equivalent. One course. *Woodbury*

**191, 192. Independent Study.** Directed reading and research for qualified juniors. Prerequisites: consent of instructor and Director of Undergraduate Studies. Two courses. *Staff*

**193, 194. Independent Study.** Directed reading and research for qualified seniors. Prerequisites: consent of instructor and Director of Undergraduate Studies. Two courses. *Staff*

### For Seniors and Graduates

**200. Programming Methodology.** Practical and theoretical topics including structured programming, specification and documentation of programs, debugging and testing strategies, choice and effective use of programming languages and systems, psychology of computer programming, proof of correctness of programs, analysis of algorithms, and properties of program schemata. Prerequisites: Computer Science 150 and 152. One course. *Gerhart*

**201. Programming Languages.** Information binding, data structures and storage, control structures, recursion, execution environments, input/output; syntax and semantics of languages; study of PL/I, Fortran, Algol, APL, LISP, SNOBOL,



and SIMULA; exercises in programming. Prerequisite: Computer Science 200. One course. *Clarke or Gerhart*

**208. Digital Computer Design.** (Also listed as Electrical Engineering 208.) One course. *Marinos or Owen*

**215. Artificial Intelligence.** Heuristic versus algorithmic methods; programming of games such as chess; theorem proving and its relation to correctness of programs; readings in simulation of cognitive processes, problem-solving, semantic memory, analogy, adaptive learning. Prerequisite: Computer Science 152 or consent of instructor. One course. *Biermann*

**221. Numerical Analysis I.** Error analysis and interval arithmetic, interpolation and polynomial approximation methods, numerical differentiation and integration, solution of simultaneous linear equations and matrix inversion, real and complex roots of nonlinear equations. Prerequisite: knowledge of an algorithmic programming language and intermediate calculus. (Also listed as Mathematics 221.) One course. *Gallie or Patrick*

**222. Numerical Analysis II.** Calculation of eigenvalues and eigenvectors, numerical methods for solving ordinary differential equations, partial differential equations, and integral equations. Prerequisite: Computer Science 221 or equivalent. (Also listed as Mathematics 222.) One course. *Patrick or Utku*

**223. Numerical Optimization.** Numerical methods for finding minima of functions of several or many variables, with and without conditions of constraint. Prerequisite: Computer Science 221 or equivalent. (Also listed as Mathematics 223.) One course. *Staff*

**225. Mathematical Foundations of Computer Science I.** Introduction to basic concepts and techniques used in mathematical models of computation. Elements of the predicate calculus; applications to automatic theorem-proving and verification of programs. Notions of computable sets, functions, algorithmically unsolvable problems. Regular and context-free formal languages and the machines that define them. Prerequisite: four semesters of college mathematics. One course. *Biermann or Loveland*

**226. Mathematical Foundations of Computer Science II.** Basic concepts and techniques used in the modeling of systems. Elements of probability, statistics, queuing theory, linear programming, linear systems, and error analysis. Prerequisites: four semesters of college mathematics. One course. *Foster*

**231. Introduction to Operating Systems.** Characteristics and components of operating systems and methods for their implementation. Program linkage and relocation, job scheduling, resource allocation and interrupt handling, input/output control systems, on-line file structures, communication, time sharing and real time systems. Case studies of existing systems. Prerequisite: Computer Science 152. One course. *Foster or Trivedi*

**232. Metaprograms.** Programs which process programs: compilers, interpreters, and assemblers. Syntax and semantics of programming languages. One course. *Gallie*

**241. Data Base Management Systems.** Basic concepts and principles. Relational, hierarchical, and network approaches to data organization; systems and language support for data base systems; theories of data organization; security and privacy issues. Prerequisites: Computer Science 150 and 152. One course. *Hammond*

**244. Computer Simulation Models of Economic Systems.** (Also listed as Economics 244.) One course. *Naylor*

**251. Computer Science for Teachers.** An introduction to digital computation which concentrates on computer instruction in the high school and on the employment of computer processes in instruction and school administration. Prerequisite: a year of basic mathematical analysis at college level. Summer session. One course. *Staff*

**252. Computer Systems Organization.** Hardware and software aspects. Processor, memory, device, and communication subsystems; case studies of hardware system organization, e.g., parallel, associative, fault tolerant; organization of software systems to exploit hardware systems organization; economic and reliability aspects of various hardware organizations. Prerequisites: Computer Science 150, 157. One course. *Trivedi*

**265. Advanced Topics in Computer Science.** One course. *Staff*

## DEPARTMENTAL MAJOR

### The B.S. Degree

*Prerequisites.* Computer Science 51; Mathematics 31, 32, 103, 104.

*Major Requirements.* Computer Science 150, 152, three of the following: 157, 163, 200, 215, 221, 225, 231, 232, 241; and Mathematics 135 or 183. If Mathematics 135 is elected, it is strongly recommended that it be followed by Mathematics 136 or 206. Students must take enough additional courses so that they have completed at least five courses (excluding Mathematics 103, 104) at the 100-level or above in one department other than Computer Science or in an approved area. A list of areas which have been approved by the department, such as the zoology-chemistry combination often chosen by premedical students, may be obtained from the Director of Undergraduate Studies.

*Honors.* Any student who is qualified (see the section on Honors in this *Bulletin* for general requirements) may undertake work leading to a degree with distinction in computer science by applying to the Director of Undergraduate Studies. Candidates must complete a substantial project, suitably documented, or a distinguished paper on which they will be examined orally by a committee of three faculty members.

Students planning to do graduate work will probably find a reading knowledge of at least one foreign language useful. Students who expect to do their graduate work in computer science should try to include Computer Science 221 and modern algebra in their course of study.

## Drama

Associate Professor Clum (English), *Director of the Program in Drama and Chairman of the Interdisciplinary Committee on Drama*; Professors Cordle (French), Fowlie (French), Krynski (Slavic Languages), and Wardropper (Spanish); Associate Professors Jezierski (Slavic Languages), Michalak (English), Reardon (English), and Stewart (Romance Languages); Assistant Professor Alt (German) and Burian (Classical Studies); Artists-in-residence Eulo, Parker, and Whiting

## PRACTICAL THEATER

**91. Introduction to Theater.** Theater history, dramatic literature and various aspects of a dramatic production. One course. *Clum and Staff*

**101. Acting.** Basic acting skills; diction, movement, improvisation, interpretation. One course. *Staff*

**102. Advanced Acting.** Advanced work in interpretation and scene study. Prerequisite: Drama 101. One course. *Staff*

**103. Directing.** Basic training in casting, blocking, and interpretation. Prerequisite: Drama 101 or consent of instructor. One course. *Staff*

**104. Stagecraft.** An introduction to technical aspects of play production: scenery, lighting, and properties. Laboratory work coordinated with productions at Duke. One course. *Parker*

**105. Educational Theater.** Training in producing and directing junior high and high school productions: play selection, casting, publicity, ticket sales, basic directing. One course. *Clum and Parker*

**106. Scene Design.** General principles of visual design as applied to scenery for the theater. Instruction in standard techniques of planning and rendering scene designs. Prerequisite: Drama 104 or consent of the instructor. One course. *Parker*

**181S. Studies in Special Topics.** One course. *Staff*

**191-194. Independent Study.** Intensive study or special projects in theater history or practical theater approved by the Committee on Drama. One course. *Staff*

See also English 130, Play Production. *Michalak*

## THEATER HISTORY

### English

119. History of the Theater. *Clum or Michalak*

## DRAMATIC LITERATURE

### Classical Studies

114. Greek Drama. *Burian*

### English

22S. Studies in Drama. *Staff*

129. English Drama from the Middle Ages through the Eighteenth Century. *Clum or Reardon*

159. English and Irish Drama of the Nineteenth and Twentieth Centuries. *Clum and Reardon*

169. Modern European Drama. *Clum or Reardon*

179. American Drama. *Clum or Reardon*

181S. Conference on Drama. *Staff*

### French

110. French Comedy in the Seventeenth and Eighteenth Centuries. *Stewart*

111. French Drama of the Nineteenth Century. *Staff*

112. French Drama of the Twentieth Century. *Cordle or Staff*

151. Theory and Form of Tragedy. *Fowlie*

233. Contemporary French Theater. *Fowlie*

### German

115S. Drama (1770-1890). *Alt*

### Romance Languages

160. An Approach to Comedy. *Wardropper*

## Slavic Languages

105. The Russian Theater and Drama. *Jezierski*

183. Slavic Drama and Theater of the Twentieth Century. *Krynski*

## MAJOR IN DRAMA

*Prerequisite.* Drama 91.

*Major Requirements.* Four courses at the 100-level in drama and three courses at the 100-level in dramatic literature or theater history selected from the offerings of participating departments. One of the seven courses must be an independent study approved by the Committee on Drama.

## Economics

Professor Kelley, *Chairman*; Professor Davies, *Director of Undergraduate Studies*; Professors Blackburn, Bronfenbrenner, Goodwin, Grabowski, Kreps, Lewis, Naylor, Saville, Trembl, Vernon, Wallace, Weintraub, and Yohe; Associate Professors de Marchi, Graham, Havrilesky, McElroy, and Tower; Assistant Professors Bolnick, Cook, Lipscombe, and Weymark

Economics courses aim to develop the critical and analytical skills essential for understanding economic problems and institutions, in both their contemporary and in their historical setting. Although no particular vocational or professional goal is emphasized, these courses provide the academic background necessary for positions in industry, for work in many branches of government service, for law school, and for graduate study in business administration, economics, and the social sciences.

Students planning to do graduate work in economics are advised to take as many of the following courses in mathematics (listed in preferential order) as their schedules permit: Mathematics 31, 32, 103, 104, 131, 135, and 136.

**1. National Income and Public Policy.** Basic economic analysis emphasizing current public policy issues. How the level and rate of growth of aggregate national income and output are determined. What causes unemployment, inflation, and international payment problems. How monetary policy (money supply and interest rates) and fiscal policy (government expenditures and taxes) affect these problems. (Open only to freshmen.) One course. *Staff*

**2. Competition, Monopoly, and Welfare.** A continuation of Economics 1. How the composition of the economy's output and distribution of its income (who is rich and who is poor) are determined in a market economy by supply and demand. How and why markets work or fail to work and the implications of social policies. Role of government in a market economy. Contemporary problems of the environment. Topics such as environmental economics, monopoly, unionism, international trade. Comparison of a market economy with other systems of economic organization. Economic problems of developing countries. (Open only to freshmen.) One course. *Staff*

**51. National Income and Public Policy.** See Economics 1. (Open to all students.) One course. *Staff*

**52. Competition, Monopoly, and Welfare.** See Economics 2. (Open to all students, except those who have had Management Sciences 50.) One course. *Staff*

**51D, 52D.** The same courses as Economics 51, 52 except taught as lectures with discussion sections. Two courses. *Staff*

**53. Economics of Contemporary Issues.** Modern economic problems, such as



environmental deterioration and urban decay. The market as one of the interrelated subsystems of the social system, from institutionalist, Marxist, and other perspectives in the social sciences. One course. *Havrilesky*

**105. Economics and Justice.** Welfare judgments and the normative background of positive economics. Foundations of distributive justice and social change. Prerequisites: Economics 52 and Mathematics 31. One course. *Weintraub*

**106. The Economics of Poverty.** Poverty in the United States: its definition, measurement, history, racial dimensions, and present and proposed policies for its amelioration. Prerequisite: Economics 52. One course. *Grabowski or Kreps*

**107. Economics of the Environment.** Theory and practical analysis of the interdependence between environmental quality and consumption, production, public policy, and economic growth. One course. *Staff*

**108. Economics of War.** Conflict theory, causes and economic consequences of war, military manpower, military-industrial complex, disarmament, and the economy. Prerequisite: Economics 52. One course. *Weintraub*

**114. Economic Geography of Africa.** A continental study of the natural environmental factors of Africa and the basic economic patterns of adjustments and adaptations on regional or national bases. One course. *Tuthill*

**115. Fundamentals of Geography.** A functional social studies approach to geographic factors and their interrelationships. One course. *Tuthill*

**116S. Economic Geography of Anglo-America.** Geographic and economic regions of the United States and Canada; their resource base and the major economic activities, their spatial distribution, and relative significance. One course. *Tuthill*

**120. Economic Geography of Asia.** Concepts of agricultural, manufacturing, and distributive location theory, resource evaluation, and regional planning in Asia. One course. *Tuthill*

**132. Development of the American Economy.** From first settlement to present: quantity of goods and quality of life; employment and leisure; domestic and foreign commerce; poverty and affluence; money and prices; slavery, agriculture, and ghettos; business and labor; and roles and policies of governments. One course. *Saville*

**134. Quantitative Analysis in Economics.** Partial derivatives. Lagrange multiplier methods, matrix theory, and difference and differential equations. Prerequisite: Mathematics 31. One course. *Staff*

**138. Economic Statistics.** Survey of principal concepts and methods of application to economics. (Not open to students who have had Mathematics 53 or 183, Management Sciences 110, Psychology 117.) One course. *McElroy, Vernon, or Wallace*

**139. Introduction to Econometrics.** Data collection, estimation, and hypothesis testing. Use of econometric models for analysis and policy. Prerequisites: Mathematics 31 and 32, or equivalent, and Economics 138 or Management Sciences 110 or equivalent. One course. *McElroy, Vernon, or Wallace*

**149. Microeconomic Theory.** Cost and supply considerations in price theory; the demand for factors of production. The allocation of resources is examined in the context of competitive and monopolistic market structures. (Not open to students who have had either Economics 161 or Public Policy Studies 110.) *Graham, McElroy, Trembl, Vernon, or Wallace*

**150. History of Economic Thought.** Includes approaches to economic problems from Aristotle to Samuelson, emphasizing certain models and doctrines—their origins, relevance, and evolution. Readings from Mun, Quesnay, Adam Smith, Malthus, Ricardo, Marx, Pareto, and Keynes. One course. *Goodwin or de Marchi*

**153. Monetary Economics.** The evolution and operations of commercial and central banking and nonbanking financial institutions in the United States, the determination of monetary aggregates and interest rates, the financial impacts of Treasury operations, and the linkages from Federal Reserve actions to price level, employment, economic growth, and balance of payments objectives. One course. *Bolnick, Havrilesky, or Yohe*

**154. Aggregate Economics.** Concepts and measurement of national income and expenditures, employment, interest rates, and price levels; the theoretical determination of these aggregates; applications of macroeconomic theory to business cycles and economic growth. One course. *Bolnick, Bronfenbrenner, Havrilesky, Tower, or Yohe*

**155. Labor and Manpower Problems.** Current issues of unemployment, wages, and incomes of nonworkers. Manpower policies and labor-force quality. Sex, age, and race differences in labor-force participation and in earnings. Prerequisite: Economics 52. One course. *Kreps*

**156. Labor Economics.** The supply of labor; human fertility; investment in persons; hours of work and labor-force participation; mobility and migration. The derived demand for labor. Wage distribution and wage structure. Unions and government in relation to labor. Prerequisite: Economics 149. One course. *Lewis*

**184. Canada: Problems and Issues of an Advanced Industrial Society.** \* (Also listed as Interdisciplinary Course 184.) *Preston and Visiting Lecturers*

**189. Business and Government.** Public policies which most directly affect the operation of competition in the business world. The economic basis for an evaluation of antitrust policy, public utility regulation, and public enterprise. Prerequisite: Economics 149 or consent of the instructor. One course. *Grabowski or Vernon*

**191, 192. Independent Study.** Directed reading and research. Prerequisites: consent of instructor and department. Two courses. *Staff*

**193, 194. Independent Study.** Same as Economics 191, 192, but for seniors. Two courses. *Staff*

**198S. Topics in Market Organization.** Market structures, related economic and legal issues, and attempted policy solutions in the United States. Prerequisite: Economics 149. One course. *Grabowski or Vernon*

### Junior-Senior Seminars in Economics

**201S.1. Current Issues in Economics.** Economic analysis of various public issues and policies. Readings, reports, and discussion on the health care system, crime and punishment, pollution and the environment, the performing arts, welfare, the energy crisis, and other topics. One course. *Davies*

**201S.2. Mathematical Economics.** Selected mathematical tools from symbolic logic, naive set theory, linear algebra, calculus, analysis, and elementary topology

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\*This course does not count toward the the courses required for an economics major.

applied to the analysis of economic problems. Topics include consumer choice, production, general equilibrium, and growth. Prerequisites: two semesters of college calculus and Economics 149. One course. *Graham*

**201S.3. Economics of Higher Education.** An analysis of the demand for educated manpower, public and private costs and benefits, the role of private higher education, public policy in higher education, and other topics. One course. *Blackburn*

**201S.4. Conflict and Cooperation in Economics.** Elements of game theory. Both cooperative and non-cooperative games with particular reference to economic problems such as trading, general equilibrium theory, oligopoly, and monopoly. One course. *Weintraub*

**201S.5. Impact Analysis of Government Policies.** The impact of government policies on income and employment utilizing methodology of input-output analysis. Applied problems: impact on environment, conflicting national priorities, technological change, marketing projections, foreign trade, shifts in demand, disarmament. One course. *Tremblay*

**201S.6. Current Problems in International Monetary Arrangements.** The breakdown of the international monetary system. Effects of alternative retaliatory schemes. Effects on the international transmission of business conditions of flexible exchange rates. Optimum stocks of international monetary reserves. Prerequisite: Economics 149 or 265. One course. *Tower*

**201S.7. Economics of Discrimination.** Analysis of the extent and effects of racial, sex, and age discrimination in the labor force; wage differentials, age-earnings profiles, and returns to education. One course. *Kreps*

**201S.8. The Economics of Population.** Relationship of population growth to economic development and to natural resource and environmental pressures. Causes and impacts of population change, including economic models of fertility, mortality, marriage, and migration. One course. *Kelley*

**201S.9. The Japanese Economy.** Historical background, present status, future prospects, rival interpretations of the long-term "miracle" of Japanese economic development. (1868-1912; 1950-1973.) One course. *Bronfenbrenner*

## For Seniors and Graduates

**200. Capitalism and Socialism.** Selected ideological classics of new and old right and left economics including both "counsels for perfection" (Utopias) and "precepts for action" in political economy. Prerequisite: Economics 149 or 154, or consent of instructor. One course. *Bronfenbrenner*

**204S. Advanced Money and Banking.** Monetary theory and its statistical and institutional implementation. Particular attention is given to the development of aggregative theories of prices, interest rates, and production; the functioning of monetary policy within various theoretical frameworks; and appraisal of the recent use and the limitations of Federal Reserve policy. One course. *Havrilesky or Yohe*

**211. Introduction to Mathematical Economics.** Applications of topics in calculus, differential equations, and linear algebra to the theory of the firm, capital theory, macroeconomics, cycles, growth, and linear economic models. Prerequisites: Economics 149 and 154 and Mathematics 31 and 32, or equivalent. One course. *Graham*

**212S. Economic Science and Economic Policy.** An historical examination of

the impact of economics on public policy; special attention to agriculture, labor relations, the Council of Economic Advisers, and the experience of other countries. Prerequisite: Economics 150. One course. *Goodwin*

**214. Geonomics: Geography and Contemporary Economics of Africa.** Environmental factors in relationship to major economic activities, emphasizing the resource base, ecological adjustments, landscape morphology, and international interdependence. A series of national studies synthesized into a continental format. Prerequisite: consent of the instructor. One course. *Tuthill*

**219. Economic Problems of Underdeveloped Areas.** Consideration and analysis of the economic and related problems of underdeveloped countries. Some attention will be given to national and international programs designed to accelerate the solution of these problems. One course. *Bolnick, Kelley, Naylor, or Saville*

**231S. Economic Development of Europe.** Sequence of local, national, and international economic structures under situations of changing trade, industry, agriculture, population, investment, war conditions, public ownership, cartels, colonialism, and prices. One course. *Saville*

**232. Economic History of Japan.** Japanese economic development, stressing the period since the end of isolation. Prerequisite: one semester of economic analysis or of Far Eastern history. (Also listed as History 260.) One course. *Bronfenbrenner*

**233. State and Urban Finance.** Expenditures, taxation, and financial administration in state and local governments, with emphasis on current problems. Special attention will be given to research methods and materials, and to the financial relations between state and local governments. One course. *Davies*

**234. Urban Economics.** Economic factors which influence the internal development of metropolitan areas. Urban problems involving slums, ghettos, poverty, and transportation are analyzed from an economic point of view. Prerequisite: Economics 149 or consent of instructor. One course. *Staff*

**235. The Economics of Crime, Law Enforcement, and Justice.** An analysis of the social costs of law enforcement and crime, a theoretical and empirical study of criminal deterrence, the measurement and production of law enforcement outputs, and an economic analysis of the courts and correctional system. Prerequisite: Economics 149 or equivalent. One course. *Cook*

**237, 238. Statistical Methods.** A study of statistical methods appropriate for dealing with problems in business and social science. In addition to developing more thoroughly the subject considered in business statistics, the following methods will be considered: simple, multiple, partial, and curvilinear correlation; curve fitting; probability; sampling distributions; and statistical inference. Prerequisite: Economics 138 or consent of the instructor. Two courses. *Staff*

**243. Econometrics I.** Economic theory, mathematics, statistical inference, and electronic computers applied to analysis of economic phenomena. Objective is to give empirical content to economic theory. Matrix algebra used to develop topics in inference, linear regression, and systems of simultaneous equations. Use is made of the electronic computer. One course. *McElroy or Wallace*

**244. Computer Simulation Models of Economic Systems.** A course on the design of computer simulation experiments for economic systems. Topics include generation of stochastic variates, computer models of queuing and inventory systems, models of the firm and industry, models of the economy, simulation lan-



guages, and experimental design. (Also listed as Computer Science 244.) One course. *Naylor*

**245. Econometrics II.** Advanced theory and applications: includes specification error, generalized least squares, lag structures, Bayesian decision-making, simultaneous equation methods, and forecasting. Emphasis on current applied literature. A Track 1, third-level course. Prerequisite: Economics 243. One course. *McElroy or Wallace*

**257. Manpower and Human Resources.** Allocation of human resources; returns to investments in education and training; qualitative composition of the labor force. One course. *Kreps*

**262. Trade Unionism and Collective Bargaining.** An intensive survey of the trade union as an economic institution is followed by a study of the principles and problems of union-management relationship as found in collective bargaining. One course. *Staff*

**265S. International Trade and Finance.** A study of fundamental principles of international economic relations. Subjects covered include the economic basis for international specialization and trade, and the economic gains from trade, the balance of international payments, problems of international finance, investments, and monetary problems. Prerequisite: Economics 149. One course. *Bronfenbrenner or Tower*

**287. Public Finance.** Economic aspects of such problems as the growth of government, the proper role of the state, the centralization and decentralization of government, government bureaucracy, the impact of taxes and spending on the wealthy and the poor as well as other public policies and questions. One course. *Davies*

**293. Soviet Economic History.** Establishment of foundations of a socialist economy: collectivization, industrialization, and search for economic efficiency. One course. *Trembl*

**294S. Soviet Economic System.** Economic planning and administration in the Soviet Union and other socialist countries. International comparisons. Theoretical and applied problems of resource allocation, economic development, and optimal micro decision-making in a nonmarket economy. One course. *Trembl*

## DEPARTMENTAL MAJOR

*Prerequisites.* Mathematics 31, Economics 1 or 51, Economics 2 or 52 (Management Sciences 50 will be accepted in lieu of Economics 2 or 52).

*Major Requirements.* Any five additional courses in the department. Substitution of courses in other departments for similar courses in the Economics Department will not be permitted. Prerequisite for admission to a junior-senior seminar are two of the following courses: Economics 138, 149, 154.

For graduation with distinction in economics, at least one junior-senior seminar course and an honors paper are required. See section on Honors for other requirements.

## Education

Professor Flowers, *Chairman*; Associate Professor Colver, *Director of Undergraduate Studies*; Professors Adams, Cartwright, Gehman, Hopkins, Katzenmeyer, Petty, Shuman, and Weitz; Associate Professors Ballantyne, Carbone, Davis, Di Bona,

Johnson, Martin, Pittilo, and Sawyer; Assistant Professor Lehane; Lecturer Williams

Students who expect to teach in the public schools should confer with Department of Education advisers prior to registration each semester. Students who intend to teach in elementary schools should consult with Professor Lehane; those intending to teach in secondary schools should consult with Professors Cartwright, Petty, or Shuman.

Students who do not expect to teach but desire an understanding of the school as part of their liberal education are advised to elect such courses as Education 100 and 113 for their introductory work in the department and then to elect further work in accordance with their special interests.

**100. Social and Philosophical Foundations of Education.** Basic features and assumptions, viewpoints, and issues of education in contemporary America. One course. *Carbone, Di Bona, or Martin*

**104. The School as an Organization.** Structure and functions; impact on students and teachers; linkages with society. Field experiences in several educational settings. Prerequisite: Education 100. One course. *Di Bona and Martin*

**105. Elementary Education: Reading.** Must be taken concurrently with Education 106. Half-course. *Adams*

**106. Elementary Education: Language Arts.** Must be taken concurrently with Education 105. Half-course. *Adams*

**107. Elementary Education: Mathematics.** Half-course. *Petty*

**108. Elementary Education: Science.** Half-course. *Lehane*

**113. History of American Education.** American education from colonial times to the present. Development of schools, their organizations, administration, curriculum, and methods in relation to the social forces which produced our particular type of civilization. One course. *Johnson*

**118. Educational Psychology.** Psychology of learning, individual and social development, and psychology of adjustment as related to problems of instruction and the process of education. Prerequisite: Psychology 102, 103, 104, or 105. One course. *Davis*

**151. Public School Music Education.** (Also listed as Music Education 151.) Half-course.

**152. Public School Music Education II.** (Also listed as Music Education 152.) Half-course.

**161. Integrated Art in the Public School.** Materials and methods in basic two-dimensional art media. Half-course. *Stars*

**162. Plastic Art in the Public School.** Basic three-dimensional art; emphasis on ceramics. Half-course. *Stars*

**168. Secondary Education: Teaching Reading.** Teaching reading in the content areas; determining students' reading levels; locating, evaluating, and selecting instructional materials. One course. *Adams*

**173, 174. Tutorial Practicum in Reading.** Assessment of reading abilities and disabilities; instruction of individuals and small groups of elementary and/or secondary students enrolled in the Duke Reading Center. Prerequisites: Education 105, 106, or Education 236, and consent of instructor. Two courses. *Adams*

**191, 192. Independent Study.** Directed reading and research for juniors. Prerequisites: approval of the instructor and the Director of Undergraduate Studies. Two courses. *Staff*

**193, 194. Independent Study.** Directed reading and research for seniors. Prerequisites: approval of the instructor and the Director of Undergraduate Studies. Two courses. *Staff*

**195S. Elementary Education: Principles.** The nature, subject matter, and organization of elementary education for instruction in the primary and intermediate grades. Must be accompanied by Education 196. Half-course. *Lehane*

**196. Elementary Education: Internship.** Full time for second half of semester. One and one-half courses. *Lehane*

### For Seniors and Graduates

**201. Mathematics Program in the Elementary School.** Objectives, curriculum, and instructional strategies. One course. *Petty*

**202. Comparative and International Education: Industrialized Nations.** Structure and functioning of educational institutions in selected developed societies. Relevant social science theory and methods. One course. *Di Bona*

**203. Seminar in Philosophical Analysis of Educational Concepts.** Selected writings of contemporary philosophers; emphasis on such educational concepts as teaching, learning, knowing, understanding, indoctrination, explanation, and education. One course. *Carbone*

**204. Educational Organization.** Theory and research on the processes of exchange between educational organizations and their external environments; influence on organizational structure, goals, and practices. Examining schools, colleges, and universities through a comparative approach with other forms of social organizations: hospitals, businesses, and prisons. One course. *Martin*

**206. Studies in the History of Educational Philosophy.** The educational views of leading thinkers in the history of Western philosophy, including Plato, Augustine, Locke, Rousseau, Kant, Whitehead, and Dewey. One course. *Carbone*

**207. Social History of Twentieth-Century American Education.** Twentieth-century American education in context of social and intellectual history. One course. *Johnson*

**209S. John Dewey.** Dewey's major writings with emphasis on his philosophy of education. One course. *Carbone*

**210. The Politics of Education.** (Also listed as Political Science 210.) One course. *Leach*

**213. Elementary School Organization and Administration.** Nursery school, kindergarten, and the elementary school. Problems of internal organization and management of elementary school and its integration with secondary school. One course. *Flowers, Petty, or Pittillo*

**215S. Secondary Education: Principles.** Principles, curriculum, and methods in secondary education. Prerequisite: C average overall and in teaching field or fields. Must be accompanied by Education 216. One course. *Cartwright, Petty, or Shuman*

**216. Secondary Education: Internship.** Supervised internship in junior and

senior high schools. Full time for half a semester. One and one-half courses. *Cartwright, Petty, or Shuman*

**217. The Psychological Principles of Education.** Advanced study of teaching, learning, and the learner. One course. *Davis, Gehman, or Weitz*

**218. Comparative and International Education: Developing Societies.** One course. *Di Bona*

**219. Comparative and International Education: South Asia.** Traditional and modern educational developments in India and Pakistan. One course. *Di Bona*

**221. Programs in Early Childhood Education.** Objectives and philosophy underlying programs in early childhood education. One course. *Lehane*

**222. New Developments in Elementary School Curriculum.** One course. *Lehane*

**223. Teaching the Language Arts.** Comparison of current methods and materials in the teaching of handwriting, spelling, and oral and written composition. Analysis and correction of basic difficulties. One course. *Adams*

**224. Teaching the Social Studies in Elementary Schools.** One course. *Cartwright*

**225. The Teaching of History and the Social Studies.** Evaluation of the objectives, content, materials, and methods in the teaching of history and the social studies. One course. *Cartwright*

**226. Teaching Developmental and Remedial Reading in the Elementary School.** Principles, methods, and materials for the development of effective reading attitudes and skills in developmental and remedial programs. One course. *Adams*

**229. Assessments of Reading Disability Cases.** Standardized tests, other methods, and informal procedures used in diagnosing reading problems of elementary and secondary pupils. One course. *Adams*

**230. Research Methods.** One course. *Sawyer*

**232. Psycho-educational Counseling with Parents.** Individual and group counseling concerning psycho-educational problems of parents and children. Prerequisite: consent of instructor. One course. *Ballantyne, Davis, or S. Gehman*

**233. Improvement of Instruction in English.** Recent developments and research techniques in the teaching of English through individual projects. Prerequisite: consent of instructor. One course. *Shuman*

**234. Secondary School Organization and Administration.** Objectives and philosophy underlying the organization and administration of the secondary school. One course. *Flowers*

**236. Teaching Developmental and Remedial Reading in the Secondary School.** Principles, methods, and materials for the development of effective reading attitudes and skills in developmental and remedial programs. One course. *Adams*

**237. Teaching of Literature in Secondary Schools.** Conventional, adult, and transitional literature are considered. One course. *Shuman*

**238. Content, Supervision, and Administration of Reading Programs.** Objectives, organization, attributes, and evaluation of reading programs. One course. *Adams*



**239. Teaching of Grammar, Composition, Mechanics, and Usage in Secondary School.** Recent developments. One course. *Shuman*

**240. Career Development.** Analysis of the world of work; socio-personal factors affecting occupational choice; theories of career development; use of occupational and educational resources. One course. *Ballantyne*

**241. Foundations of Counseling and Personnel Services.** Scope, principles, historical background, services, trends, and issues of counseling, and pupil personnel services. One course. *Ballantyne*

**243. Personality Dynamics.** Personality structure and dynamics emphasizing implications for counseling and instruction. Prerequisite: six hours of psychology or educational psychology. One course. *S. Gehman*

**244. Counseling Techniques.** Individual counseling techniques; diagnosis, interviewing, program planning, and counseling evaluation. Prerequisites: Education 243 and 258 or equivalent, which may be taken concurrently. One course. *S. Gehman*

**245. Theories of Counseling.** One course. *Weitz*

**246. Teaching of Mathematics.** Aims, curriculum, and classroom procedure for teaching secondary school mathematics. One course.

**247. Practicum in Guidance and Counseling.** Local field experience in counseling and guidance program. Minimum of 150 hours of case work and supervision. Prerequisites: Education 244 and consent of instructor. One course. (May be repeated.) *Ballantyne, Colver, Gehman, or Weitz*

**248. Practicum in Counseling.** Individual counseling; test administration, intake interviewing, diagnosis, program planning, report preparation and evaluation. Minimum of 150 hours of case work and conferences with the supervisor. Prerequisite: consent of instructor. One course. (May be repeated.) *Ballantyne, Gehman, or Weitz*

**249. Exceptional Children.** Survey of major categories of exceptional children: mentally retarded, emotionally disturbed, brain injured, learning disabled, physically handicapped, visual and auditory deficient, culturally deprived, and gifted. Etiology (biological and environmental factors), diagnosis, and treatment. One course. *Davis*

**250, 251. Teaching Emotionally Disturbed Children: Internship.** Basic principles and practices in teaching and organization of instructional materials. Work with children under supervision of a certified teacher of emotionally disturbed children. Experience in general classroom, small group, and individualized instruction. Participation in staff conferences with psychiatrists, psychologists, social case workers, and professional educators. Two courses. *S. Gehman*

**253. Introduction to Law and Education.** Basic elements of legal research, with primary emphasis on concepts and procedures relevant to educational problems. Analysis of selected cases. One course. *Martin*

**254. Law and Higher Education.** Concepts and procedures relating to higher education. Emphasis upon court decisions. Prerequisite: Education 253 or consent of instructor. One course. *Flowers*

**255. Assessment of Abilities.** The selection, use, and interpretation of various instruments for predicting and evaluating the outcome of educational experiences

including surveys of standardized tests of aptitude and achievement. One course. *Colver*

**256. Classroom Assessment of Student Achievement.** The techniques used by classroom teachers to evaluate student progress. Special emphasis will be directed to tests written by teachers. One course. *Colver*

**258. Assessment of Personality, Interests, and Attitudes.** Rationale, construction, use, and interpretation of standardized instruments designed for the assessment of students' interests, attitudes, and personalities. Emphasis on counseling applications. Prerequisites: Education 243 and 255 or consent of instructor. One course. *Colver or Weitz*

**259. Problems in Law and Education.** Current issues; researching of cases, constitutional decisions, and statutes. Prerequisite: Education 253 or consent of instructor. One course. *Flowers, Martin, or Pittillo*

**260. Educational Research I.** Research design, univariate quantitative methods, and applications of the computer to research problems. One course. *Katzenmeyer*

**261. Educational Research II.** Analysis of covariance and multiple regression, discriminant function analysis, computer applications in research. Prerequisite: Education 260 or its equivalent. One course. *Katzenmeyer*

**262. Educational Research III.** Multivariate analysis of variance, factor analysis, cluster analysis, and path analysis. Education 262 is offered only in a block with Education 261. One course. *Katzenmeyer*

**266. Basic Science for Teachers.** Natural and physical science through selected readings, the use of experiments and demonstrations, construction and use of equipment, and field studies. One course.

**268. Seminar in Contemporary Educational Criticism.** One course. *Carbone, Di Bona, Johnson, or Martin*

**270. Junior and Community College.** History, philosophy, and roles. Introductory course for future teachers, counselors, or administrators in a two-year college. One course. *Hopkins*

**271. Instructional Systems for College and University Teaching.** Special attention to alternative systems, and the individualization of instruction for a heterogeneous student population. One course. *Hopkins*

**272. Teaching Communication Skills in Early Childhood Education.** From birth to age eight with emphasis on reading readiness and language growth. One course. *Adams*

**273, 274. Clinical Reading Practicum.** Experiences in the diagnosis and correction of reading disabilities in elementary and secondary students. Prerequisite: consent of instructor. Two courses. *Adams*

**276. The Teaching of High School Science.** Discussion, lectures, and collateral reading related to such topics as aims, tests, curriculum, classroom and laboratory procedure, field trips, and course and lesson planning for secondary-school science. One course.

**285. Audiovisual Aids in Education.** Aims and psychological bases of audiovisual materials in the classroom. Offered in summer only. One course.

**291. Public and Community Relations of Schools.** One course.

DEPARTMENTAL MAJOR

Majors in education are offered in elementary school education and science education. The department offers work leading to graduation with distinction. See the section on Honors in this *Bulletin*.

Duke University is accredited by the National Council for Accreditation of Teacher Education for the preparation of elementary and secondary school teachers. The programs are also approved by the North Carolina Department of Public Education.

The program for students who intend to teach is designed to prepare them for positions in either elementary or secondary schools. Prerequisites for all prospective teachers are Psychology 102, 103, 104, or 105, preferably during the sophomore year; and Education 100 or 113. Only students with a C average or higher overall and in the major or teaching fields will be admitted to student teaching. Special methods courses should be taken prior to undergraduate student teaching, which is part of a planned professional semester in the senior year.

**Elementary Education.** A major in this program is designed for those students who desire to meet the certification requirements for teaching in the elementary school.

Required General Courses

English	1 course or by examination
Foreign language	Second year (or equivalent) or 2 courses in fine or practical arts
Natural Science	2 courses
Mathematics	1 course
History 91, 92	2 courses
Political Science 91	1 course
Economics 115 or 120	1 course
Literature	1 course
Psychology 102, 103, 104, or 105	1 course

Required Specialized Subject Matter Courses

Physical Education (for Early Childhood or Intermediate Grades)	½ course
Health Education 134	½ course
Music Education 151, 152	1 course
Education 161, 162	1 course
Education 105	½ course
Education 106	½ course
Education 107	½ course
Education 108	½ course

Required Professional Courses

Education 100 or 113	1 course
Education 118	1 course
Education 1955	½ course
Education 196	1½ courses

A major in elementary education must include the concentration of at least six courses in subjects commonly taught in elementary school, chosen from one of the divisions—humanities, natural science, or social science. The concentration may include courses from the general education requirement.

**Secondary School Teaching.** Whatever their majors, students preparing to teach must consult the appropriate adviser in the Department of Education prior to each registration period to assure that they will be eligible to enter the required student teaching program. Students preparing to teach in a secondary school meet certification requirements by qualifying in one teaching field. Prospective second-

ary school teachers must major in a subject other than education. Qualifications for certification to teach a single science may be sought under either the A.B. or the B.S. degree. Students desiring to major in science education should read the description of that program given below.

**Science Education.** Students intending to teach sciences in secondary schools may major in science education. The program meets certification requirements and provides a broad background in several sciences. Early consultation with advisers in the Department of Education and a selected department in science or mathematics is required. Six courses in education (100 or 113, 118, 215S, 216, 236, and 246, or 276) are required. The Science Education program requires two courses in mathematics and laboratory work in at least three sciences, with concentration in one of these, and must include a minimum of four advanced courses.

A major in science education leads to an A.B. degree with the normal thirty-two course limit. Students wishing to have the B.S. degree may expect to take more than thirty-two courses.

**Materials and Methods Courses.** Certain materials and methods courses on teaching various subjects in the public school curriculum are listed in the proper subject matter department. These courses are intended to meet requirements for for teaching certificates.

## STUDENT TEACHING

During the period of student teaching, students may be required to live in a community which is some distance from Durham. This will entail additional living expenses to be borne by the student teacher. Room rent is not refunded.

## English

Professor Budd, *Chairman*; Associate Professor Butters, *Director of Undergraduate Studies*; Associate Professor Gerber, *Supervisor of Freshman Instruction*; Professors Anderson, Cady, Duffey, Ferguson, Nygard, Price, Randall, Reiss, Ryals, Smith, Turner, and Williams; Associate Professors Applewhite, Clum, DeNeef, Harwell, Jackson, Jones, Mellown, Michalak, Monsman, Reardon, and Strandberg; Assistant Professor Dearlove; Instructor Schwartz

## WRITING AND LANGUAGE

**1. Freshman Composition.** Weekly expository themes based on British and American prose fiction and non-fiction; one general lecture, one section meeting, and one individual conference each week. One section of this course is reserved for students interested in creative writing. One course. *Staff*

**10. Introductory Composition and Literature.** A skills course in composition and literature (contemporary essays and short stories), with frequent writing assignments: five meetings each week and regular individual conferences. (This course, offered in the Summer Transitional Program, does not satisfy the English composition proficiency requirement.) One course. *Staff*

**59. Film Criticism.** Introduction to principles of writing about the cinema. One course. *Clum, Jones, Monsman, or Strandberg*

**65S, 66S. Imaginative Writing.** Informal essay, short story, poetry, drama, and film. Prerequisite: consent of instructor. Two courses. *Monsman*

**101S. Advanced Expository Writing.** Techniques of effective writing. One course. *Butters, Ferguson, or Harwell*



**103S, 104S. Creative Writing.** Class discussion of students' manuscripts and individual conferences with the instructor. Open to sophomores, juniors, and seniors. Students desiring admission to either course should present a piece of writing to the instructor as early as possible during the preceding semester. Two courses. *Applewhite, Monsman, or Price*

**105S. The Composition of Prose Narrative.** The writing of a novel or novella or a group of short stories. Primarily for juniors and seniors; consent of instructor is required early in the preceding semester. One course. *Price*

**106S. The Writing of Poetry.** A study of meter, image, tone, and dramatic organization in traditional and modern poems as a basis for original composition. Prerequisite: consent of instructor. One course. *Applewhite*

**107. Introduction to Linguistics.** Origin and nature of language; methods of descriptive linguistics with reference to historical and comparative linguistics. (Also listed as Anthropology 107.) One course. *Staff*

**108. Development of the English Language.** An elementary historical study of the English language: patterns of change and growth, with some attention to methods of philological inquiry and the relations of philology to literary studies. One course. *Butters*

**109. Modern English Grammar.** A descriptive study of written and spoken American English of the present time, with attention to standards of usage and pronunciation, and the relations of grammar to composition. One course. *Butters*

## ENGLISH AND AMERICAN LITERATURE

**Introduction to Literature.** One course each; English 26 may be taken twice.

20. (This number represents one course credit for advanced placement.)

21S. Studies in the Novel.

22S. Studies in Drama.

23S. Studies in the Short Story.

24S. Studies in Poetry.

25S. Studies in the Epic.

**26. Studies in Special Topics.** (Some sections are taught as seminars; see the *Schedule of Courses*.)

**55, 56. Representative British Writers.** First semester: selections from Chaucer, Shakespeare, Donne, and Milton. Second semester: Swift or Fielding, Austen or Dickens, Joyce or Forster, Pope, the Romantics, the Victorians, Yeats, and Pinter. Two courses. *Staff*

**57, 58. Representative American Writers.** Selections and complete works. First semester: Poe, Emerson or Thoreau, Hawthorne, Melville, Whitman, Dickinson, and Twain. Second semester: James, Frost or Robinson, Crane or Dreiser, O'Neill, Faulkner, Hemingway, and others. Prospective majors should take courses numbered 161-162, 171-172, instead of these courses. Two courses. *Staff*

**112. English Literature of the Middle Ages.** A study of the principal forms and examples of English prose, poetry, and drama of the Anglo-Saxon and Middle English periods (excluding Chaucer), read in translation. One course. *Reiss*

**113. Chaucer.** *The Canterbury Tales* and the minor poems, with attention to their literary and social background. One course. *DeNeef, Nygard, Reiss, or Schwartz*

**121. English Literature of the Sixteenth Century.** Emphasis in poetry on Wyatt, Sidney, Spenser, Raleigh, Shakespeare; in prose on Sidney and Florio's *Montaigne*; in drama on Marlowe. One course. *DeNeef*

**123, 124. Shakespeare.** First semester: twelve plays before 1600. Second semester: about ten plays after 1600. Two courses. *DeNeef, Jones, Schwartz, or Williams*

**125, 126. English Literature of the Seventeenth Century.** First semester: emphasis in poetry on Jonson and the cavaliers, Donne and the metaphysicals; in drama on Jonson, Tourneur, Webster, Ford; in prose on character writers, Bacon, Burton, Donne, Browne. Second semester: emphasis in poetry on later metaphysicals, Cowley, Denham, Waller, Dryden; in prose on Taylor, Dryden, Hobbes, Locke; in drama on Dryden, Congreve, Etherege, Wycherly. Two courses. *DeNeef or Randall*

**127. Milton.** Milton's poetry and prose, their relation to the period and to other great works of literature. One course. *DeNeef or Price*

**129. English Drama from the Middle Ages through the Eighteenth Century.** Emphasis on Tudor and Stuart drama, exclusive of Shakespeare. One course. *Clum or Reardon*

**131. Eighteenth-Century Literature.** Traditions and values of Augustan and post-Augustan literature with emphasis on genre and intellectual history. Addison, Swift, Pope, Gray, Johnson, Blake, and Defoe or Fielding are usually studied. One course. *Ferguson or Jackson*

**133. Studies in a Major British Author.** Readings in the works of such pre-1800 writers as Dryden, Fielding, Pope, or Johnson. One course. *Staff*

**138. The English Novel in the Eighteenth Century.** Defoe, Richardson, Fielding, Smollett, and Sterne; the Gothic novel. One course. *Ferguson or Jackson*

**141, 142. English Literature of the Early Nineteenth Century.** The course begins with the forerunners of Romanticism. The chief emphasis in the first semester is on the work of the older Romantics: Wordsworth, Coleridge, Lamb, and Hazlitt. In the second semester the chief emphasis is on the work of the younger Romantics: Byron, Shelly, Keats, and DeQuincey. Two courses. *Applewhite*

**143. Studies in a Major British Author.** Readings in the works of such post-1800 writers as Coleridge, Eliot, Wordsworth, or Yeats. One course. *Staff*

**145. English Literature, 1832-1900.** Major writers and genres, with special emphasis on Carlyle, Tennyson, Browning, Arnold, the Pre-Raphaelites, and Hopkins. Collateral reading from novels. One course. *Harwell, Monsman, or Ryals*

**148. The English Novel in the Nineteenth Century.** Some of the writers studied are Scott, Austen, Dickens, Thackeray, Trollope, the Brontes, George Eliot, Meredith, Butler, and Hardy. One course. *Harwell or Monsman*

**151, 152. English Literature of the Twentieth Century.** Emphasis on principal writers of fiction, drama, and poetry. First semester: usually Conrad, Shaw, Yeats, Wells, Synge, Forster, Woolf, and Joyce. Second semester: usually Lawrence, Cary, Huxley, Auden, Greene, Beckett, and Dylan Thomas. Two courses. *Dearlove, Mel-lown, or Smith*

**154. British Poetry of the Twentieth Century.** Changes in poetry and its criticism from the Edwardians. Yeats, Housman, Lawrence, Owen, the Sitwells, Graves,

Auden, MacNeice, Dylan Thomas, Hughes, and Larkin. One course. *Dearlove, Mellown, or Smith*

**158. The English Novel in the Twentieth Century.** Some of the writers studied are Conrad, Lawrence, Forster, Joyce, Woolf, Huxley, Cary, Amis, and Golding. One course. *Dearlove, Mellown, or Smith*

**159. English and Irish Drama of the Nineteenth and Twentieth Centuries.** Emphasis on the modern period. One course. *Clum or Reardon*

**161. American Literature to 1800.** Colonial authors, Bradford, Taylor, Cotton Mather, Edwards, Byrd, and Franklin, and authors of the early Republic such as Tyler, Freneau, and C.B. Brown. One course. *Jones*

**162. American Literature, 1800 to 1860.** Prose and poetry of American Romanticism: Emerson, Thoreau, Hawthorne, Poe, Melville, and Whitman. (Not open to students who have taken English 57.) One course. *Staff*

**163. Studies in a Major American Author.** Readings in the works of such writers as Faulkner, Hawthorne, James, or Whitman. One course. *Staff*

**164. American Poetry of the Twentieth Century.** The classicism of Pound, Eliot, and the Fugitives in relation to the neo-romanticism of Stevens, Williams, Crane, and Roethke. Developments during World War II and after: Lowell, Jarrell, Berryman, Dickey, Levertov, and Wright. One course. *Applewhite, Duffey, or Standberg*

**171. American Literature, 1860 to 1915.** Dickinson, Twain, James, the social and philosophical essayists, Crane, Dreiser, Robinson, and Frost. (Not open to students who have taken English 58.) One course. *Staff*

**172. American Literature, 1915 to 1960.** Eliot, Fitzgerald, Hemingway, Faulkner, and their contemporaries. One course. *Staff*

**175. Contemporary American Writers.** Novelists and poets prominent in the recent past. One course. *Staff*

**177, 178. American Fiction.** A survey of the novel and the short story. First semester: nineteenth century from Washington Irving to Stephen Crane. Second semester: twentieth century through ten representative books. Two courses. *Anderson, Budd, or Clum*

**179. American Drama.** Representative plays from Colonial times to the present: a historical survey. One course. *Clum or Reardon*

**Conference Courses.** Seminars primarily for majors, with priority given to seniors. Emphasis on literary theory and critical writing with intensive study of one or more authors. One course each; each course may be taken twice.

**180S. Conference on Criticism.**

**181S. Conference on Drama.**

**182S. Conference on Poetry.**

**183S. Conference on Fiction.**

**184S. Conference on Prose Non-Fiction or a Special Topic.**

**188. The Origins and Aims of Narrative.** Readings in ancient, middle, and modern narrative literature—epic, tale, drama, novel—with attention to the origins of the narrative impulse, its evolution from sacred to secular, its deducible purposes, and its present manifestations. One course. *Price*

**191, 192, 193, 194. Independent Study.** Directed reading and research. Stu-

dents should consult the Director of Undergraduate Studies as early as possible in the semester preceding enrollment. Up to one course each. *Staff*

**195T. Tutorial.** Directed reading and research. Prerequisite: consent of the Director of Undergraduate Studies in the preceding semester. One course. *Staff*

**197T, 198T. Distinction in English.** Tutorials in the reading and criticism of selected British and American writers. Three essays the first term; three essays or an extended paper the second term. Upon recommendation of the tutors and completion of other requirements, the student may graduate with distinction in English. Admission by invitation of the department; students expecting to graduate early may take these courses in reverse sequence, beginning in the spring term preceding their graduation. Two courses. *Anderson*

## FOREIGN LITERATURES (IN TRANSLATION)

**165. Readings in Scandinavian Literature.** A study of selections in translation from Ibsen, Strindberg, Lagerkvist, and others; their place in the literary tradition of Scandinavia and their relationships with English and American Literature. One course. *Anderson*

**166. The Bible as Literature.** Detailed study of selected books of Old and New Testament and Apocrypha, emphasizing their literary form and artistry and their various expressions in world literature. Course will also include a history of the Bible in English. One course. *Reiss*

**167. Canadian Literature in English.** Survey of nineteenth-century writers. Emphasis on twentieth-century poets and novelists such as E.J. Pratt, F.R. Scott, A.J.M. Smith, Earle Birney, Sinclair Ross, Hugh MacLennan, Irving Layton, Leonard Cohen, and Margaret Atwood. One course. *Staff*

**168. Readings in European Literature.** Works of European literature related to similar works in English: Montaigne, Rabelais, Cervantes, Voltaire, Dostoevsky, and others. One course. *Harwell*

**169. Modern European Drama.** Ibsen to the present; the free theater movement and the drama of ideas. One course. *Clum or Reardon*

## SPEECH AND THEATER

**50. Essentials of Public Speaking.** A basic course in public speaking, designed to give the student the poise and confidence necessary to think and speak freely before an audience. Particular attention is paid to the gathering and organization of speech materials and to oral presentation. Not open ordinarily to juniors and seniors. One course. *Michalak*

**100. English for Foreign Students.** A non-credit course which includes an individual tutorial stressing writing and a small class emphasizing conversation and pronunciation. The tutorial is restricted to registered undergraduate and graduate foreign students. *Staff*

**110. Essentials of Public Speaking.** A basic course in public speaking for juniors and seniors dealing with the same matters as English 50. (Not open for credit to students who have taken English 50.) One course. *Michalak*

**119. History of the Theater.** The origin and development of drama, acting, and stagecraft from ancient Greece to the modern European and American theater. Production problems of representative plays of the various periods will be dis-



cussed. Primarily for juniors and seniors; open also to sophomores with consent of instructor. One course. *Clum or Michalak*

**120. The Speaking Voice.** Mechanisms of speech; skills necessary for the improvement of voice, pronunciation, and diction. Methods of correcting minor functional speech disorders. One course.

**130. Play Production.** An introduction to the methods of producing a play-theater organization, play selection, casting, and rehearsal. Lectures and laboratory. Primarily for juniors and seniors; open also to sophomores approved by the instructor. One course. *Michalak*

**140S. Argumentation.** The principles of argumentation and debating. The techniques of analysis, investigation, evidence, reasoning, brief making, and refutation. Participation in class discussion and debates. Prerequisite: consent of instructor. One course.

**150. Persuasive Speaking.** The psychological and sociological techniques used in gaining acceptance of ideas through speech. Study is made of the factors influencing human behavior; audience analysis and motivation; choice, arrangement, and adaptation of material. Extensive practice in persuasive speaking. One course.

**160, 170. Broadcasting.** A study of the background of radio and television broadcasting. First semester: the development of broadcasting as an industry and as a literary form. Second semester: legal and social aspects, and various program forms. Two courses.

#### For Seniors and Graduates

**207. Old English Grammar and Readings.** One course. *Nygard or Reiss*

**208. History of the English Language.** Introductory survey of the changes in sounds, forms, and vocabulary of the English language from its beginning to the present, with emphasis on the evolution of the language as a medium of literary expression. One course. *Nygard or Reiss*

**209. Present-Day English.** A description of present-day American English from the point of view of modern linguistic theory; comparison of traditional and structural grammars; semantic change; the relation of the written to the spoken language; usage. One course. *Butters, Nygard, or Reiss*

**210. Old English Literary Tradition.** Prerequisite: English 207. One course. *Nygard or Reiss*

**212. Middle English Literary Tradition.** From 1100 to 1500 (excluding Chaucer); medieval genres; reading of selected texts. A reading knowledge of Middle English is recommended. One course. *Nygard or Reiss*

**215. Chaucer.** *The Canterbury Tales*. One course. *Nygard or Reiss*

**216. Chaucer.** *Troilus and Criseyde* and the minor poems. One course. *Nygard or Reiss*

**221. English Prose and Poetry of the Sixteenth Century.** Readings in the major non-dramatic forms and authors from Sir Thomas More to John Donne, excluding Spenser's *Faerie Queene*. *DeNeef*

**223. Spenser.** One course. *DeNeef*

**224. Shakespeare.** The plays. One course. *Williams*

**225, 226. Tudor and Stuart Drama, 1500-1642.** First semester: Peele, Lyly, Greene, Kyd, Dekker, Heywood, Chapman, and Marston, with emphasis on Marlowe. Second semester: Jonson, Webster, Beaumont, Fletcher, Massinger, Middleton, Ford, and Shirley. Two courses. *Randall*

**229, 230. English Literature of the Seventeenth Century.** The first semester includes works in prose and poetry from 1600 to about 1660, and the second semester includes prose, poetry, and some drama from about 1660 to 1700. Two courses. *DeNeef (229), Jackson (230), Randall (229, 230), or Williams (229)*

**232. Milton.** Milton's poetry and prose, with emphasis on the major poems. One course. *DeNeef*

**234. English Drama, 1642-1800.** The heroic play and comedy of manners of the Restoration; the important plays, serious and comic, of the eighteenth century. One course. *Jackson*

**235, 236. The Eighteenth Century.** First semester: Swift, Pope, Defoe, Addison, Steele, and others. Second semester: Gray, Johnson, Boswell, Collins, Goldsmith, the novelists, and other writers. Two courses. *Ferguson or Jackson*

**241, 242. English Literature of the Early Nineteenth Century.** First semester: poets and prose writers, 1790-1810, with emphasis on Wordsworth and Coleridge. Second semester: 1810-1830, with emphasis on Byron, Shelley, and Keats. Two courses. *Monsman*

**245, 246. English Literature of the Later Nineteenth Century.** First semester: Carlyle, Dickens, Thackeray, Tennyson, and Browning. Second semester: Arnold, Ruskin, Pater, George Eliot, Meredith, the Pre-Raphaelites, and Swinburne. Two courses. *Monsman or Ryals*

**251, 252. English Literature of the Twentieth Century.** Representative work of leading writers from 1900 to 1950, in fiction, drama, and poetry. First semester: Shaw, Conrad, Yeats, Wells, Bennett, Galsworthy, Ford, Synge, Forster, and Lawrence. Second semester: Joyce, Woolf, Edith Sitwell, Eliot, Huxley, Graves, Bowen, Auden, and Dylan Thomas. Critical analysis of selected texts, with discussion of techniques and ideas. Two courses. *Mellown or Smith*

**263, 264. American Literature, 1800-1865.** Emphasized in the first semester are Emerson, Thoreau, and Hawthorne; in the second semester, Poe and Melville. Two courses. *Anderson, Jones, or Turner*

**267, 268. American Literature, 1865-1915.** Selected works of representative authors. First semester: Whitman, Mark Twain, James, Howells, Dickinson, and the Local Colorists. Second semester: Crane, Norris, Dreiser, Cather or Wharton, O'Neill, Robinson, and Frost. Two courses. *Budd or Cady*

**270, 271. Southern Literature.** Emphasis in the first semester is on Byrd, Kennedy, Simms, Poe, Timrod, and the humorists; in the second, on Lanier, Harris, Cable, Twain, Glasgow, and Faulkner. Two courses. *Turner*

**275, 276. American Literature since 1915.** First semester: selected fiction from Gertrude Stein to the present. Second semester: poetry from the Imagist movement to the present. Two courses. *Duffey or Strandberg*

**280. Introduction to Folklore.** A survey of the materials of popular tradition, the folksong, the folktale, the proverb, the riddle, and other forms; the methods of folklore investigation; and the relation of these popular genres to literary tradition. One course. *Nygard*

**285. Literary Criticism.** Readings from the major critics, Plato to the eighteenth century, with emphasis on formative ideas and historical continuity. One course. *Jackson*

**287. Theory of Literature from Kant to the Present.** A survey of literary theory: intellectual currents of Romanticism, the classic revival, the realistic schools, symbolism, the recent analytic schools. One course. *Duffey*

## DEPARTMENTAL MAJOR

*Basic Requirement.* English 55-56.

*Major Requirements.* Seven courses at the 100-level or above. One course in a major author; three courses in period surveys, one in each division: (a) British Literature before 1800, (b) British Literature after 1800, (c) American Literature; and three additional courses.

In choosing the three additional courses, students should carefully consider with their advisers the opportunities available in the departmental offerings for concentration in English or American literature; in poetry, fiction, or dramatic literature; in historical periods; in critical theory, linguistics, or creative writing; or in speech and theater.

The English Department recommends that its majors complete at least two years of college-level study, or the equivalent, of a foreign language. Those majors contemplating graduate work in English should note that many master's programs require examination in one foreign language and that doctoral programs commonly require examination in two.

*Honors.* The department offers work leading to graduation with distinction. For further information consult the Director of Undergraduate Studies and the section on Honors in this *Bulletin*.

## Forestry and Environmental Studies

Students in arts and sciences who are preparing for professional careers in forest resource sciences or administration should refer to the section on Professional Combination Programs in this *Bulletin*. The courses listed below are open to undergraduate students in arts and sciences by consent of the instructor. The courses are described in the *Bulletin of the School of Forestry and Environmental Studies*.

### FORESTRY

**152. Conserving Natural Resources.** One course. *Staff*

**203. General Meteorology.** Prerequisites: introductory courses in calculus and physics. One course. *Vukovich*

**204. Microclimatology.** Prerequisites: introductory courses in calculus and physics. One course. *Knoerr*

**205. Tree Growth and Development.** Prerequisites: introductory courses in botany and chemistry. One course. *Barnes*

**206. Anatomy of Woody Plants.** Prerequisite: Forestry 241 or plant anatomy. (Also listed as Botany 206.) One course. *Philpott*

**215. Air Pollution Meteorology.** Prerequisite: Forestry 203 or equivalent. (Course sponsored by Triangle Universities Consortium on Air Pollution and taught by faculty from North Carolina State University.) One course. *Staff*

**217L. Environmental Instrumentation.** (Also listed as Botany 217L.) One course. *Knoerr*

**222. Biology of Forest Insects and Diseases.** Prerequisites: introductory courses in biology and physiology. One course. *Anderson and Stambaugh*

**233. General Entomology.** Prerequisite: Forestry 222 or equivalent. One course. *Anderson*

**241. Dendrology (Taxonomy of Forest Trees).** Prerequisite: introductory course in botany. One course. *White*

**250. Biometry.** Prerequisite: introductory courses in calculus. One course. *Yandle*

**269. Resource Economics and Policy.** Prerequisite: introductory course in economics. One course. *Convery*

## ENVIRONMENTAL STUDIES

**243. Natural Resource Ecology.** Prerequisite: introductory course in botany. One course. *Wuenscher*

**273. Economics and Environmental Quality.** Prerequisite: introductory course in economics. One course. *Convery*

## French

For courses offered in French, see Romance Languages.

## Genetics—The University Program

Professor Gross, *Director* (Biochemistry); Professors Amos (Microbiology and Immunology), Gillham (Zoology), Guild (Biochemistry) and Webster (Biochemistry); Associate Professors Antonovics (Botany), Boynton (Botany), Counce (Anatomy), and C. Ward (Zoology); Assistant Professors Hall (Biochemistry), Kredich (Medicine and Biochemistry), Modrich (Biochemistry) and F. Ward (Microbiology and Immunology)

The University Program in Genetics provides a coherent course of study in all facets of biology related to genetics. Students interested in preparation for advanced work in genetics or wishing to take an interdisciplinary major in this area should consult Dr. C. Ward (032 Biological Sciences Building). Information concerning interdisciplinary programs involving biology should be discussed with the appropriate directors of undergraduate studies.

The following courses are described in the listing of the specified departments:

**Genetics and Society.** (Zoology 117.) One course. *Ward*

**Principles of Genetics.** (Botany 180, Botany 280 L, Zoology 180, and Zoology 180L.) One course. *Antonovics, Boynton, and Gillham*

**Evolutionary Mechanisms.** (Botany 186 and Zoology 186.) One course. *Antonovics and H. Wilbur* (Zoology)

**Introductory Genetics.** (Biochemistry 204.) Half-course. *Gross and Staff*

**Molecular Genetics.** (Biochemistry 216.) One course. *Guild and Staff*

**Experimental Genetics.** (Biochemistry 282.) Half-course. *Modrich and Staff*



**Current Topics in Genetic Mechanisms.** (Biochemistry 284.) Half-course. *Hall and Staff*

**Population Genetics.** (Botany 285S.) One course. *Antonovics*

**Quantitative Genetics.** (Botany 287S.) One course. *Antonovics*

**The Cell in Development and Heredity.** (Anatomy 288 and Zoology 288S.) Half-course. *Counce*

*Independent Study* and *Special Problems* are offered in the Department of Botany under numbers 191, 192, 193, 194, 225, and 226, and in the Department of Zoology under numbers 191, 192, 193, and 194. Students should obtain the consent of both the instructor with whom they wish to work and the appropriate director of undergraduate studies before registering for these courses.

## Geography

For courses in Geography, see Economics.

## Geology

Professor Heron, *Chairman*; Associate Professor Furbish, *Director of Undergraduate Studies*; Professors Perkins and Pilkey; Associate Professor Lynts; Assistant Professor Rosendahl

**1. Geological Environments and Man.** Physical and chemical environments acting on the earth with special emphasis on their interaction with man. Three lectures and proficiency sessions to be arranged by students. One course. *Heron or Perkins*

**3. Environmental Geology.** Earth processes and materials, as related to man. Lectures, field-trip, and eight hours of mini-lab. Not open to those who have completed Geology 1. One course. *Heron*

**10. Analysis of Outcrops.** Field interpretation of geologic features. A four-hour field trip once a month. Prerequisite: Geology 1 or 3 (may be taken concurrently). Half-course. *Staff*

**12. Geology, Resources, and Society.** Lectures, proficiency sessions, and field trips. Not open to students who have completed Geology 3. Prerequisite: Geology 1 or consent of instructor. One course. *Heron and Pilkey*

**53. Introductory Oceanography.** Basic principles of physical, chemical, biological, and geological oceanography. Prerequisite: one course in a laboratory science. (Also listed as Botany 53.) One course. *Pilkey and Searles* (Botany)

**72. History of the Earth.** Physical and biological evolution of the earth from the viewpoint of the global tectonics. Primarily for science majors. Lectures, student-arranged laboratory sessions, weekend field trip through the Appalachians, and Saturday field trip through the Deep River Triassic Basin. Prerequisite: Geology 1 or consent of instructor. One course. *Lynts*

**101. Crystallographic Mineralogy.** Definition of the crystalline state, lattice and group concepts, indices, crystal systems, classification, and crystal morphology. Lectures and laboratory. One course. *Furbish*

**102. Fundamentals of Mineralogy.** Crystal chemistry, crystal physics, mineral identification, and genesis. Lectures or recitations, laboratory, and field trips. Pre-

requisites: Chemistry 12 (may be taken concurrently) and Geology 101. One course. *Furbish*

**103. Intensive Study of Geological Environments and Man.** Physical and chemical environments acting on the earth with special emphasis on their interaction with man. Lectures and proficiency sessions. (Also listed as Geology 1). One course. *Heron or Perkins*

**104. Intensive Study of Geology, Resources, and Society.** Lectures, proficiency sessions, and field trips. Not open to students who have completed Geology 3. Prerequisite: Geology 1 or consent of instructor. (Also listed as Geology 12.) One course. *Heron*

**106. Igneous and Metamorphic Rocks.** Silicate mineralogy, theory of origin and classification of igneous and metamorphic rocks and rock identification. Lectures and laboratory. Prerequisite: Geology 102. One course. *Furbish*

**108. Sedimentary Rocks.** Authigenic and detrital minerals, theory of origin and classification of sedimentary rocks and rock identification. Lecture, laboratory, and field trips. Prerequisite: Geology 1. One course. *Heron*

**164. Introduction to Geologic Field Methods.** Principles and techniques used in geologic mapping and field studies including applicable methods of surveying and the use of aerial photographs. Lectures, laboratory, and field trips. Prerequisites: Geology 1 and 72. One course. *Furbish*

**168. Introductory Geological Oceanography.** A study of elementary geological principles relating to the modern oceans. Field observations of beach and estuarine processes and the study of historical development of the ocean basins. Prerequisite: introductory geology course or consent of instructor. (Given at Beaufort.) One and one-half courses. *Goll*

**169. The Marine Environment.** For description see Marine Sciences.

**171. Marine Sciences Seminar.** For description see Marine Sciences.

**191, 192. Independent Study.** Directed reading and research. Open only to qualified juniors and seniors by permission of the Director of Undergraduate Studies. Two courses. *Staff*

**195. Problems in Earth Science.** Open to qualified non-major juniors and seniors upon approval of the department. One course. *Staff*

#### **For Advanced Undergraduates and Graduates**

**205. Geological Oceanography.** Broad geological aspects of the ocean basins including origin, bottom physiography, sediment distribution, submarine sedimentary processes and shoreline processes. Field observations; sampling procedures. Not open to students who have completed Geology 206. Given at Beaufort. One and one-half courses. *Glaeser and Pilkey*

**206S. Principles of Geological Oceanography.** A survey of geological aspects of the oceans including sediment types, processes of sedimentation, geologic structures of the ocean basins, and bottom physiography. Not open to students who have had Geology 205. Prerequisite: Geology 108 or consent of instructor. One course. *Pilkey*

**208. Shallow-Marine Geology.** Physical and biological processes responsible for sediment production, accumulation, and alteration in the shallow-marine envi-

ronment. Prerequisite: Geology 108 or consent of instructor. Given biennially. One course. *Perkins*

**211S. Stratigraphic Principles and Application.** Prerequisite: Geology 108. One course. *Perkins*

**212. Facies Analysis.** Sedimentological models for the environmental interpretation of sedimentary sequences. Prerequisite: Geology 211. One course. *Perkins*

**214S. Sediments in Thin Section.** Study of sediments and sedimentary rocks using the petrographic microscope and related techniques. Prerequisite: consent of instructor. One course. *Perkins*

**222. Sedimentary Minerals.** Structure and geologic occurrences of selective detrital and authigenic minerals including the clay minerals. Theory and use of X-ray diffraction, differential thermal analysis, and thermal gravimetric analysis. Prerequisite: Geology 102 or consent of instructor. One course. *Heron*

**229. Economic Geology.** Principles and processes involved when elements are concentrated to economic proportions in magmatic, metamorphic, hydrothermal, sedimentary, or surface environments. Prerequisites: Geology 102. Given on demand. One course. *Furbish*

**230. Principles of Structural Geology.** Description, origin, and interpretation of primary and secondary geologic rock structures. Prerequisites: Geology 106 and 108. One course. *Rosendahl*

**241-242. Invertebrate Paleontology.** Biologic and stratigraphic relationships of fossil invertebrates, with special emphasis on evolutionary trends of invertebrates as interpreted from fossil evidence. Lectures and laboratory. Prerequisites: Geology 1, 72, or consent of instructor. Given biennially. Two courses. *Lynts*

**243-244. Micropaleontology.** Microscopic animal and plant fossils, exclusive of spores and pollen, with special emphasis on their biology, taxonomy, evolution, and stratigraphic distribution. Lectures and laboratory. Prerequisites: Geology 241-242, or consent of instructor. Given biennially. Two courses. *Lynts*

**247. Paleoecology.** Application of ecologic and geologic principles to the reconstruction of the interrelationship between organisms and their environment in geologic time. Prerequisites: Geology 108, 242, or consent of instructor. Given biennially. One course. *Lynts*

**250. Introduction to Marine Geophysics.** Topics include seismic reflection and refraction, magnetics, gravity, and seismology. Prerequisite: introductory physics or consent of instructor. (Given at Beaufort.) One and one-half courses. *Rosendahl*

**251. Principles of Geophysics.** Theory, techniques, and interpretation. Aspects of seismology, geomagnetism, gravity, and heat flow. Prerequisites: Physics 52, Calculus 32, and Geology 1, or consent of instructor. One course. *Rosendahl*

**252. Marine Geophysics.** Survey of methods in the study of the oceanic crust and mantle. Prerequisite: Geology 251 or consent of instructor. Given biennially. One course. *Rosendahl*

## DEPARTMENTAL MAJOR

### The A.B. Degree

*Prerequisites.* Geology 1 and 72, Chemistry 11 and 12, and Mathematics 31 and 32.

*Major Requirements.* A minimum of eight geology courses above the introductory levels, including 101, 102, 106, 108, 164, 211, and 230.

## The B.S. Degree

The Department of Geology offers two programs:

**1. Geology: Preparatory to Advanced Studies in Geology**

*Prerequisites.* Geology 1 and 72; Chemistry 11 and 12; Mathematics 31, 32; Physics 41 and 42 or 51 and 52; and Computer Science 51.

*Major Requirements.* A minimum of ten courses above the introductory level including 101, 102, 106, 108, 211, 230, plus a field course normally taken during the summer of the junior year.

**2. Geology: Preparatory to Advanced Studies in Oceanography**

*Prerequisites.* Geology 1 and 72, and 53 (or 206); Chemistry 11 and 12; Physics 41 and 42 or 51 and 52; Biology 11 and 12 or Biology 14; Mathematics 31 and 32, and three courses of science electives.

*Major Requirements.* A minimum of seven geology courses above the introductory level, including 101, 102, 106, 108, 164, 211S, and 230.

## Germanic Languages and Literature

Professor Phelps, *Chairman*; Assistant Professor Bessent, *Director of Undergraduate Studies*; Assistant Professor Rosenberg, *Supervisor of Freshman Instruction*; Professor Jantz; Associate Professors Borchardt and Rolleston; Assistant Professor Alt

**1-2. Elementary German.** Practice in understanding, speaking, reading, and writing. Classroom techniques are combined with those of the language laboratory. Two courses. *Rosenberg and Staff*

**63. Intermediate German.** Prerequisite: German 1-2 or equivalent. One course. *Staff*

German 63 is usually followed by 101, 117, or 182.

**101. Introduction to German Literature.** Readings from representative German authors. One course. *Bessent*

**103S, 104S. Seminars in German Literature in English Translation.** Topics to be specified each semester. Two courses. *Staff*

**105. Composition.** Syntax with practice in the elements of German expository style, restricted to majors. One course. *Staff*

**109S. Nineteenth-Century Prose Fiction.** Emphasis on shorter forms: novelle, fairy tale, legend. One course. *Bessent*

**115S. Drama (1770-1890).** History of German drama and stagecraft from *Sturm und Drang* to the *Freie Bühne*. One course. *Alt or Rosenberg*

**117S, 118S. German Conversation and Composition.** Primarily conversation with oral and written reports, based on works by contemporary writers of East and West Germany. Required for German majors and other students by consent of instructor. Two courses. *Bessent*

**119S. German Literature to the Goethezeit.** Survey of German literature and its cultural backgrounds from the beginning through the Enlightenment. One course. *Alt or Rolleston*



**125, 126. The Moderns.** Problems and authors from Nietzsche and naturalism through expressionism to the present. Two courses. *Alt or Rolleston*

**127. Contemporary Germany.** The current literary scene in the two Germanies in its cultural, social, and political contexts. One course. *Staff*

**130. German Life and Thought.** German cultural and intellectual history. Reading and discussion in English. One course. *Borchardt*

**131. Goethezeit.** Goethe and his contemporaries: representative texts and the philosophical background. One course. *Phelps*

**132. The Romantics.** Major writers of the Romantic movement (1796-1830) considered in their national and international context. One course. *Rolleston*

**171. German Literature before 1900 in English Translation.** One course. *Borchardt*

**172. Modern German Literature in English Translation.** Representative works by such writers as Mann, Kafka, Hesse, Brecht, Böll, and Grass. One course. *Borchardt*

**181, 182. German.** An intensive introduction to the language open only to students who have achieved proficiency in another language. Not open for credit to students who have completed German 1 and 2 or the equivalent. Two courses. *Staff*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified students in the junior year, by consent of the department. Two courses. *Alt, Bessent, Borchardt, Phelps, Rolleston, or Rosenberg*

**193, 194. Independent Study.** Directed reading and research. Open only to qualified students in the senior year, by consent of the department. Two courses. *Alt, Bessent, Borchardt, Phelps, Rolleston, or Rosenberg*

#### For Seniors and Graduates

**201S, 202S. Goethe.** His life and works, in the light of his lasting significance to Germany and world literature. First semester: lyrics, prose, fiction, and selected dramas; second semester: *Faust I & II*. Two courses. *Jantz or Phelps*

**203S. Eighteenth Century.** Eighteenth-century German literature in its relation to European intellectual currents of that time. One course. *Phelps*

**205, 206. Middle High German.** The language and literature of Germany's first classical period. Two courses. *Rosenberg*

**207S. German Romanticism.** The principal writers of the period from 1796 to 1830. One course. *Rolleston*

**209S. Drama.** Studies in the German-speaking theater with emphasis on the nineteenth century. One course. *Alt*

**211S. Nineteenth-Century Literature.** From the end of Romanticism through Realism. One course. *Alt*

**214S. The Twentieth Century.** Literature of the twentieth century presented through representative authors. One course. *Rolleston*

**215S. Seventeenth-Century Literature.** Leading writers of the Baroque, viewed against the background of their time. One course. *Borchardt*

**216. History of the German Language.** Development of the phonology, morphology, and syntax of German from the beginnings to the present. One course. *Rosenberg*

**217S. Renaissance and Reformation Literature.** The period from 1400 to about 1600. One course. *Borchardt*

**218S. The Teaching of German.** A survey of modern teaching techniques: problems in the teaching of German on the secondary and college levels. Analysis and evaluation of textbooks and related audiovisual materials. One course. *Phelps*

**219. Applied Linguistics.** The application of modern linguistic principles to a systematic study of the phonetics, morphology, and syntax of modern German. Prerequisite: consent of the instructor. One course. *Rosenberg*

**230. Lyric Poetry.** Studies in poetry and poetic theory. From Goethe and the Romantics to Rilke, Benn, and contemporary authors. One course. *Rolleston*

**232. Criticism.** Critical concepts, craft of interpretation, and readings from the great critics. One course. *Alt or Borchardt*

## YIDDISH

**171. Yiddish Fiction in Translation.** Representative works of the classics (Mendele, Peretz, Sholem Aleichem, Asch, Goldfaden) as well as of selected poets. One course. *Alt*

**181, 182. Elementary Yiddish.** A thorough study of elementary Yiddish grammar with reading, composition, and oral practice. No previous knowledge of German or Hebrew required. Two courses. *Alt*

**191, 192. Independent Study.** Two courses. *Alt*

## DEPARTMENTAL MAJOR

*Prerequisites.* Elementary and Intermediate German.

*Major Requirements.* Conversation and composition (German 117, 118, or equivalent), plus six advanced courses, three of which must be on the 200-level. The following courses may not be used to fulfill major requirements: 103S, 104S, 171, 172, 181, 182.

*Honors.* Any student who is qualified (see the section on Honors in this *Bulletin* for general requirements) may undertake work toward a degree with distinction in German by applying to the chairman or departmental representative for the Honors Program. In addition to meeting the requirements of a major in the department, the candidate for graduation with distinction is encouraged to take one or more courses in Independent Study and German 232. Further information is available at the departmental office, 104 Languages Building.

## Greek

For courses in Greek, see Classical Studies.

## Health, Physical Education, and Recreation

Professor Friedrich, *Chairman*; Associate Professor Skinner, *Director of Undergraduate Studies*; Professors Bookhout, Buehler, and Falcone; Associate Professors Corrie, Cox, Eddy, Persons, Riebel, Spangler, Uhrhane, and Woodyard; Assistant

Professors Harvey, LeBar, Lloyd, Raynor, and Wray; Instructors Howard and White; Part-time Instructors Barton, Morris, and Myers

## PHYSICAL EDUCATION ACTIVITY COURSES

The activity courses listed below may be taken by men and women unless otherwise indicated. Each course carries a half-course credit and is given on a pass/fail basis. The maximum amount of credit which a student may earn for elective activity courses is one full course.

**4. Beginning and Intermediate Equitation.** Including trail riding for those with good control in the canter. Experience unnecessary. Fee of \$96 covers twenty-four mounted lessons and one in stable management. Half-course. *Swanson*

**6. Equitation: Hunt Seat.** Riding according to U.S. Pony Club standards. Position at all paces, increase and decrease of pace, turns, circles, jumping. Trail rides. Fee of \$110 for twenty-four mounted lessons and two on saddlery. Half-course. *Gosling*

**7. Equitation: Combined Training.** Dressage, crosscountry, and stadium jumping. Prerequisites: ownership of horse; the United States Combined Training Preliminary Level or the United States Pony Club "B" rating. Fee of \$50 per semester. Half-course. *Gosling*

**10. Individual Activity Programs.** Varies with student's objectives. Prerequisite: consent of instructor. Half-course. *Skinner*

**11, 12. Adapted Physical Education.** Exercises, conditioning, or special activities to meet needs of individual students. Two half-courses. *Riebel*

**14. Tension Control.** Basic skills and practice in recognizing, controlling, and reducing tension. Techniques including Jacobson's Progressive Relaxation, autogenic procedures, and meditative methods. Half-course. *Riebel*

**15. Individual Development: Aerobics, Weight Training, Conditioning.** A planned program of progressive, cumulative, and measurable physical activities adapted to individual needs. Designed to increase fitness. Half-course. *Staff*

**16. Jogging.** Emphasis on individualized programs. Half-course. *Buehler*

**17. Water Polo.** Basic techniques including game tactics and strategy. Prerequisite: departmental swim test. Half-course. *Barton*

**20. Beginning Swimming.** Techniques for water safety: breathing control, floating, and elementary swimming. Half-course. *Staff*

**21. Intermediate Swimming.** Stroke techniques and diving. Resuscitation. Prerequisite: Physical Education 20 or the equivalent. Half-course. *Staff*

**22. Endurance Swimming.** Review of strokes and improvement through progressive practice. Half-course. *Spangler*

**23. Beginning Kayaking.** Development of all phases of single kayaking. Lake and river experience provided. Fee. Half-course. *Harvey*

**24. Advanced Lifesaving: New Materials of American Red Cross.** Red Cross Advanced Lifesaving Certificate issued upon satisfactory completion. Prerequisite: Physical Education 21 or equivalent. Half-course. *Staff*

**25. Water Safety Instructors Course: New Materials of American Red Cross.**

Red Cross Water Safety Instructors Certificate upon satisfactory completion. Prerequisite: Physical Education 24 or equivalent. Half-course. *Staff*

**26. Advanced Swimming and Water Safety.** Swimming as an avocation or vocation. Prerequisite: advanced lifesaving or water safety instruction or equivalent. Half-course. *Persons*

**27. Scuba Diving.** An intermediate course. Prerequisite: consent of the instructor. Fee of \$10 covers use of specialized equipment. Half-course. *Staff*

**28. Whitewater Canoeing.** Fee covers rental of equipment. Prerequisite: departmental swim test. Half-course. *Riebel*

**29. Beginning Sailing.** On campus and Kerr Lake. Prerequisite: departmental swim test. Half-course. *Buehler*

**30. Beginning Golf.** Fee. Half-course. *Staff*

**31. Intermediate and Advanced Golf.** Wood shots, iron shots, approaching, and putting. Fee. Prerequisite: Physical Education 30 or equivalent instruction. Half-course. *Staff*

**32. Handball, Racquetball, Squash.** No previous experience necessary. Half-course. *Skinner*

**33. Fencing.** Basic skills emphasizing foil fencing. Half-course. *LeBar*

**37. Archery, Badminton.** Archery in good weather; badminton in poor weather. Competition. No previous experience necessary. Half-course. *Staff*

**38. Snow Skiing.** Basic instruction in techniques of snow skiing. Fee of \$80 covers rental of equipment, daily slope fees, housing for five nights and daily instruction on slopes and ski lodge. Half-course. *Riebel*

**39. Bowling: Beginning and Advanced Techniques.** Fee. Half-course. *Corrie and Spangler*

**40. Beginning Tennis.** Half-course. *Staff*

**41. Intermediate Tennis.** Introduction to volley, lob, and smash. Competition in singles and doubles. Prerequisite: Physical Education 40 or equivalent. Half-course. *Staff*

**42. Advanced Tennis.** Review of strokes with emphasis on strategy and placement. Singles and doubles competition. Prerequisite: Physical Education 41 or equivalent. Half-course. *Staff*

**43. Power Volleyball.** Introduction to the basic skills. Half-course. *Staff*

**45. Trampoline and Floor Exercise.** Beginning skills and techniques. Half-course. *Staff*

**46. Women's Gymnastics.** Introduction to balance beam, vaulting, and uneven parallel bars; emphasis on competitive gymnastic skills. Half-course. *Staff*

**48. Self-Defense.** Course content varies: boxing, wrestling, judo, karate, or tae kwan-do. Half-course. *Falcone and Staff*

**50. Field Hockey.** Basic skills. Conditioning, rules, and analysis of strategy. Half-course. *Staff*

**51. Soccer, Lacrosse.** Fundamentals of individual skills and team play. Half-course. *Skinner*



**52. Women's Lacrosse.** Basic skills. Half-course. *Staff*

**53. Basketball.** Basic and advanced skills. Half-course. *Staff*

**91. First Aid.** Knowledge and practical skill for dealing with emergency situations, for personal safety, and accident prevention. Meets American Red Cross requirements for the Standard First Aid and Personal Safety Certificate. One course. *Lloyd*

**92. Cardiopulmonary Resuscitation.** The techniques of artificial respiration and artificial circulation. Half-course. *Persons*

**93. Cardiopulmonary Resuscitation Instructors Course.** Prerequisite: Physical Education 92. Half-course. *Persons*

## THEORY COURSES IN PHYSICAL EDUCATION AND RECREATION

**102. Physical Education for Early Childhood.** Theory and practice in teaching basic skills, rhythms, and games to young children in grades K-3. Half-course. *Spangler*

**103. Physical Education for the Intermediate Grades.** Planning, organizing, and conducting physical education programs for children in grades 4-9. Half-course. *Spangler*

**105. Group Leadership in Recreation.** Interaction and group dynamics. Open to sophomores, juniors, and seniors. One course. *Morris*

**106. Methods and Materials in Recreation.** Development of leadership skills in crafts, rhythmic activities, social recreation, and dramatics. Laboratory work includes experience with an organized recreational group. Open to sophomores, juniors, and seniors. One course. *Staff*

**113D. Anatomical Bases for Human Movement.** The function of bones, joints, and muscles in human movement. One course. *Bookhout*

**114. Kinesiology.** A study of muscle function and analysis of human movement. Prerequisite: Physical Education 113D or Zoology 108L. One course. *Bookhout*

**117. Adapted Physical Education.** Analysis of exercises and activities appropriate to individual needs. Theory and practice in planning and conducting adapted programs. Half-course. *Bookhout*

**146. Women in Sports.** Emergence of women in sports. Changing social concepts affecting the status of the woman athlete and her participation in sports. One course. *Lloyd*

**163. Coaching Baseball and Track in Secondary Schools.** Theory and practice. Open to juniors and seniors. One course. *Buehler and Butters*

**164. Coaching Basketball and Football in the Secondary Schools.** Theory and practice techniques in football. Open to juniors and seniors. One course. *Falcone and Foster*

**166. Coaching Basketball in the Secondary Schools.** Theory and practice of coaching techniques in basketball. Open to juniors and seniors. One course. *Foster*

**170. History and Principles of Physical Education and Sports.** The objectives and scientific principles upon which physical education is based. The history of

physical education is studied to show the changes in objectives, principles, and methods as an aid in the interpretation of trends. One course. *Friedrich*

**171. Recreational Administration and Leadership.** Theories and philosophies of play and recreation with emphasis on leadership and application to community organizations, school, and family situations. One course. *Friedrich*

**172. The Administration of Physical Education and Athletics in Secondary Schools.** A case study of appraisal of athletics, health, and physical education problems experienced in the organization and administration of athletics, health, and physical education. Open to juniors and seniors. One course. *Friedrich*

**173. Protective Practices in Physical Education.** Safety and protective measures, including training and rehabilitation. Open to juniors and seniors. One course. *Staff*

**175. Psychology of Sport.** This course will deal with the psychological aspects of sports including: (1) personalities of athletes and coaches, (2) motivation, (3) self-image development (4) stress and anxiety, (5) aggression, (6) leadership, (7) group dynamics, (8) self-management. The course is designed for the student who wishes to learn the practical application of these psychological phenomena and how they relate to sport. One course. *Goetz and Skinner*

**191. Independent Study.** Open to qualified juniors and seniors. One course. *Staff*

**192. Independent Study.** Open to qualified juniors and seniors. One course. *Staff*

**195S. Recent Research in Physical Education and Related Fields.** One course. *Staff*

## HEALTH EDUCATION

**134. School Health.** Organization of the school health program; basic health problems in school; methods and materials for teaching about health. Primarily designed for students preparing to teach in elementary or secondary schools. Juniors and seniors only. Half-course. *Uhrhane*

**137S. Health in Developing Countries.** Health conditions, practices, and problems interacting with economics, productivity, and progress of emerging nations with some emphasis on African states. One course. *Staff*

**138S. Health Problems in Metropolitan Areas.** Relationships between urbanization and health illustrated by environmental hazards, population motion, food distribution, housing, city planning, poverty, drug usage, and consumer awareness. One course. *Staff*

**140S. Gerontology and Health.** Health implications in relationships within families and between generations, in the changing role of the elderly in modern society, in retirement, and in extended leisure time; illness, disability, and medical care. One course. *Staff*

**174. School Health Problems.** Emphasizes health problems of school age children. Drugs, alcohol, tobacco, disease and accident prevention and control, mental and emotional health and healthful school environment. One course. *Friedrich*

**170T. Special Health Problems.** Problems and issues in health affairs selected by students for concentrated study. One course. *Staff*

**191, 192, 193, 194. Independent Study.** Prerequisite: consent of instructor. One course each. *Staff*

## DANCE

Technique and theory courses are offered for undergraduate men and women who have special interest in dance as an art form.

### Technique Courses

**60. Beginning Modern Dance I.** Modern dance as an art form: techniques, choreography, history, philosophy, and aesthetics. Half-course. *Wray*

**61. Beginning Modern Dance II.** Prerequisite: Physical Education 60. Half-course. *Wray*

**62. Intermediate Modern Dance I.** Movement and expression. Prerequisite: Physical Education 61. Half-course. *White*

**63. Intermediate Modern Dance II.** Prerequisite: Physical Education 62. Half-course. *White*

**64. Advanced Modern Dance.** Prerequisite: Physical Education 63. Half-course. *White*

**65. Beginning Improvisation.** Movement experimentation. Prerequisite: Physical Education 61. Half-course. *White*

**66. Modern Dance Repertory.** Choreography of the well-known artists. Prerequisite: Physical Education 64. Half-course. *Staff*

**67. Folk Dancing.** Dances of a particular country or area and study of related music, folklore, and costumes. Half-course. *Wray*

**68. Ballroom Dancing.** Waltz, foxtrot, jitterbug, tango, samba, cha-cha, and polka. Half-course. *White*

**69. Beginning Tap Dancing.** Basic step patterns and routines. Half-course. *White*

**70. Ballet.** Prerequisite: one year of training in the strict classical form. Half-course. *Staff*

**71. Intermediate Ballet.** Prerequisite: two years of ballet and consent of instructor. Half-course. *Staff*

**80. Individual Dance Program.** Varies with technique being taught, student's objectives, and student's ability. Prerequisite: consent of instructor. Half-course. *Staff*

### Theory Courses

The courses listed below are in the areas of dance history, composition, teaching, and non-verbal communication. Courses 130S, 131S, 133S meet distributional requirements in the social science division. Physical Education 113D and 114, listed under the Physical Education Theory Courses, are closely related to the study of dance.

**130S, 131S, 133S. History of Dance.** Emphasis on form, structure, and content related to culture of eras. Physical Education 130S, prehistoric to Duncan; Physical

Education 131S, Duncan to Cunningham; Physical Education 133S, Cunningham to the present. Three courses. *White or Wray*

**132. Creative Movement for Children.** Basic theory and experience in creative movements for grades K-12. The study of the classification and elements of movement with observation and practical experience with children. Recommended for those students interested in dance, music, recreation, or elementary and secondary teaching. One course. *Wray*

**135, 136. Principles of Contemporary Dance Composition.** Prerequisite: Physical Education 60, 61, and 62, or consent of instructor. Two courses. *White*

**139. Movement Connotations.** Theories and forms of human movement with emphasis on sensory awareness and non-verbal communication. One course. *Wray*

**191, 192. Independent Study.** Open to qualified juniors and seniors. Two courses. *White or Wray*

## History

Professor Durden, *Chairman*; Professor Hollyday, *Director of Undergraduate Studies*; Professors Colton, Davis, Ferguson, Holley, Lerner, Parker, Preston, Ropp, A. Scott, W. Scott, TePaske, Watson, and Young; Associate Professors Cahow, Cell, Chafe, Gavins, Goodwyn, Hartwig, Maier, Mauskopf, Miller, Nathans, Witt, and Wood; Assistant Professors Bergquist, Calkins, Decker, di Corcia, Dirlik, J. Scott, and Stone; Instructor Kunst; Visiting Professors Addington and Higginbotham; Lecturer Bronfenbrenner; Part-time Lecturer Kuniholm; Part-time Instructors Griert and Hummer

History courses offer students from all disciplines within the University an opportunity to investigate the past, gain perspective on the present, and improve their critical faculties. History provides an integrating principle for the entire learning process. Students of history gain a sense of human development, an understanding of fundamental and lasting social processes, and a feeling for man's interrelatedness. History courses train the mind by improving skills in communicating thought and imagination.

### PREREQUISITE COURSES

Majors take a year sequence of two prerequisite courses in history (21-22, 21S-22S, 53-54, 91-92, 175D-176D), beginning either semester. Other students are urged, but not required, to take two semesters of prerequisite courses before proceeding to advanced-level courses. Additional courses may be chosen from this group as electives or part of the departmental major.

**21. Europe to the Eighteenth Century.** Development and world impact of European civilization; critical evaluation of historical interpretations; investigation of history from primary sources. One course. *Staff*

**21S. Europe to the Eighteenth Century.** A seminar version of History 21. One course. *Staff*

**22. Europe From the Eighteenth Century.** Development and world impact of European civilization; critical evaluation of historical interpretations; investigation of history from primary sources. One course. *Staff*

**22S. Europe From the Eighteenth Century.** A seminar version of History 22. One course. *Staff*



**53. Greek History.** (Also listed as Classical Studies 53.) One course. *Raschke*

**54. Roman History.** (Also listed as Classical Studies 54.) One course. *Raschke*

**91. The Development of American Democracy to 1865.** A study of the trends vital to an understanding of the United States today. The main theme is the development of American Democracy. Problems of foreign policy, the growth of capitalism, political practices, social reform, and conflicting ideals are considered in relation to this main theme. One course. *Staff*

**92. The Development of American Democracy, 1865 to the Present.** A continuation of History 91 with emphasis upon the emergence of contemporary problems in the United States. One course. *Staff*

**175D, 176D. From Tradition to Revolution.** Social, political, and economic changes in Africa, India, Pakistan, Bangla Desh, Latin America, China, and Japan. Social and political organizations, belief systems, and environmental settings. Two courses. *Staff*

## UNDERGRADUATE COLLOQUIA

Colloquia are open without prerequisite to all undergraduates and are designed for the non-specialist, although history majors may take them for credit. Each colloquium consists of reading and discussion involving an explicit historical theme. Short papers, reports, and a final examination may be required. Unlike seminars, which emphasize materials and methods of historical research, colloquia concentrate on historical literature.

**101A. Modern Japan in the Novel.** Literature in translation as a resource for the investigation of topics including Western influence, changing Japanese attitudes toward the West and toward their own culture, and Japanese perception of social change. One course. *Stone*

**101C. Representative Europeans.** Autobiographical and biographical approaches to major intellectual, political, and aesthetic trends in modern Europe. One course. *Hollyday*

**101D. Science in the Twentieth Century.** One course. *Mauskopf*

## OTHER UNDERGRADUATE COURSES

**95. The Roman Revolution.** (Also listed as Classical Studies 137.) *Staff*

**96. Early Greece and the Near East.** (Also listed as Classical Studies 133.) *Staff*

**103. The Economic, Social, and Political Institutions of Europe, 1250-1600.** One course. *Witt*

**104. The Intellectual Life of Europe, 1250-1600.** One course. *Witt*

**105, 106. Political and Constitutional History of England.** The origins and evolution of the principal institutions of the English government, related to their setting in a changing society. Two courses. *J. Scott*

**107, 108. Social and Cultural History of England.** English history from the fourteenth century to the present time in an effort to arrive at a synthesis of ideas, social conditions, and political events and thus provide a background for the study of English literature. Two courses. *Ferguson*

**111, 112. The Colonial History of the United States and the American Revolution.** Two courses. *Wood*

**113, 114. The United States from the 1890s to World War II.** First semester to 1920. Second semester through the New Deal. Two courses. *Watson*

**115, 116. History of Africa.** Social, political, and economic development in tropical Africa. First semester: cultural background and pre-colonial history. Second semester: colonial and contemporary times. Two courses. *Hartwig*

**117, 118. European Imperialism and Colonialism.** Structure and ideology of Western imperialism from the Age of Expansion through the Vietnam War and its impact upon Western societies. Two courses. *Cell*

**119, 120. History of Socialism and Communism.** The origins and development of socialist and communist movements from pre-Marxian times to the present. Two courses. *Lerner*

**121, 122. Diplomatic History of the United States.** Emphasis on those factors, foreign and domestic, that have shaped the foreign policies of the Republic. Two courses. *Davis*

**123, 124. City and Frontier in United States History.** The westward movement and the progress of urbanization with attention to the social and political consequences. Two courses. *Decker or A. Scott*

**125. The Athenian Empire.** (Also listed as Classical Studies 134.) One course. *Staff*

**126. Alexander the Great.** (Also listed as Classical Studies 135.) One course. *Staff*

**128. The United States and Latin America.** Economic, cultural, political, and diplomatic relationships in the twentieth century. One course. *Bergquist*

**129, 130. Society and Government in the United States 1789-1877.** Two courses. *Nathans*

**131. Mexico and the Caribbean from the Wars of Independence to the Present.** One course. *TePaske*

**132. Major South American Nations, 1850 to the Present.** Comparative development of export economies of Brazil, Argentina, Colombia, Chile, and Venezuela and impact on social structure, politics, and culture. One course. *Bergquist*

**133. Medieval Europe, 300-1000 A.D.** One course. *Young*

**134. Medieval Europe, 1000-1400 A.D.** One course. *Young*

**135. Political, Economic, and Social History of Europe, 1890-1933.** The challenge of social democracy, nationalism, and the rise of facism; World War I and the Great Depression. One course. *Maier*

**136. Europe Since 1933.** Nazi Germany and Hitler's Europe, popular fronts and resistance movements, left-wing culture since the Spanish Civil War, the role of the United States and of decolonization on post-war stability. One course. *Maier*

**137, 138. Foreign Relations of the European Powers.** European diplomacy and Europe's position in the world since 1870, with an introductory survey of diplomatic institutions since the Renaissance. Two courses. *W. Scott*

**139. Europe in the Age of National Unification.** Clash of nationalities, conflict

between monarchic conservatism and liberalism, romanticism, and realism in literature and art; emphasis on central Europe from Metternich to 1871. One course. *Hollyday*

**140. Europe in the Era of German Ascendancy.** International tensions, industrialization, socialism, state intervention, Darwinism, expressionism in art and literature, crises in Imperial Germany and Austria-Hungary from Bismarck to the collapse in 1918. One course. *Hollyday*

**141. Man and Society in Traditional China.** Chinese thought and institutions from earliest times to the nineteenth century. One course. *Dirlik*

**142. The Roots of the Revolution.** Nineteenth- and twentieth-century China. One course. *Dirlik*

**143, 144. History of Modern Japan.** Japan from 1600 to the present; the transition from the traditional to the modern state. Two courses. *Stone*

**145, 146. Afro-American History.** The Black experience in America from slavery to the present. (Also listed as Black Studies 145, 146.) Two courses. *Gavins*

**147. History of India to 1707.** Early development, classical Hindu civilization, the impact of Islam, first modern contacts. One course.

**148. History of India and Pakistan, 1707 to the Present.** Decay of the Mughal Empire, social and economic impact of Western rule, development of nationalism and independence. One course.

**149. Military History.** War, politics, and technology. One course. *Addington or Ropp*

**150S. The Concept of the Democratic Faith.** One course. *Cahow*

**151. Modern Technology.** Emphasis on Western technology in the nineteenth and twentieth centuries as related to political, economic, and scientific trends. One course. *Ropp*

**153S. The Insurgent South.** (Also listed as Interdisciplinary Course 153S.) Not open to students who have taken History 199 or Interdisciplinary Course 199. Prerequisite: consent of instructor. One course. *Goodwyn*

**154. Medieval England.** One course. *Young*

**155, 156. Modern Latin America.** First semester: nineteenth century. Second semester: twentieth century. Two courses. *Bergquist*

**157, 158. The Rise of Modern Science.** The development of science and medicine, with attention to cultural and social influences upon science. First semester: through Newton. Second semester: eighteenth to twentieth centuries. Two courses. *Mauskopf*

**159S. The Palestine Problem and United States Public Policy.** (Also listed as Public Policy Studies 175S.) One course. *Kuniholm*

**160. The United States from the New Deal to the Present.** One course. *Chafe*

**161, 162. History of Modern Russia.** First semester: origins of Kievan Russia in the ninth century through the reign of Catherine the Great (1762-1796), concentrating on the formation of the imperial state, class elites, and psychological interpretations of the rulers. Second semester: nineteenth and early twentieth century to the death of Lenin, stressing the opposition movements in society. Two courses. *Lerner or Miller*

**163. The Old South, 1820-1861.** One course. *Durden*

**164. The Origins of the New South, 1861-1900.** One course. *Durden*

**167, 168. Modern European Intellectual and Cultural History.** Leading European thinkers from the Enlightenment to the present. Two courses.

**169, 170. The Search for the American Woman: A New Approach to Social History.** Prerequisite: History 91, 92. Two courses. *A. Scott*

**173, 174. History of Spain and the Spanish Empire from Late Medieval Times to the Present.** First semester: unification and development of the empire in Europe and America, emphasizing colonial institutions and culture, 1450-1670. Second semester: fall of the empire and modern development through the Franco Regime. Two courses. *TePaske*

**175D, 176D. From Tradition to Revolution.** (See description under Prerequisite Courses listed above.) Two courses. *Staff*

**177. China since 1949: The Peoples' Republic.** The Chinese path to communism and the communist transformation of Chinese society. One course. *Dirlik*

**178. Diplomacy of the United States Since 1939.** One course. *Davis or Kuniholm*

**179, 180. Bourbon, Revolutionary, and Napoleonic France.** Development of the Bourbon monarchy and social self-conceptions; causes, patterns, and meanings of the Revolution; Napoleon's relation to Bourbon and Republican France and to Europe. Two courses. *di Corcia*

**181, 182. Development of Modern Medicine.** Two courses.

**183S. Canada from the French Settlement.** Problems in the development of Canada and its provinces. One course. *Preston*

**184. Canada: Problems and Issues of an Advanced Industrial Society.** (Also listed as Interdisciplinary Course 184.) One course. *Preston and Visiting Lecturers*

**185, 186. Revolution in the Modern World.** Survey of theories of revolution (Marxist, sociological, and historical), followed by a comparative study of the Great Revolutions (English, American, French, Russian) and of the revolution and resistance to Colonialism in the Third World (including Cuba, Africa, India, China, and Vietnam). Two courses. *Cell*

**187. Canada and the United States: Their Diplomatic Relations.** One course. *Davis*

**193, 194. Introduction to the Civilizations of Southern Asia.** (Also listed as Interdisciplinary Course 101, 102.) Two courses.

### **For Seniors and Graduates**

Students may receive credit for either semester of a hyphenated course at the 200-level without taking the other semester if they obtain written consent from the instructor.

**201S, 202S. Aspects of Change in Prerevolutionary Russia.** Origin and dynamics of the Russian revolutionary movement, the intelligentsia, and the emergence of the labor movement. Two courses. *Miller*

**203. The Uses of History in Public Policy I.** (Also listed as Public Policy Sciences 271.) One course. *Goodwyn*



**204. The Uses of History in Public Policy II.** (Also listed as Public Policy Sciences 273.) One course. *Kuniholm*

**205S. The Progressive Era in the United States and World War I.** One course. *Watson*

**206S. The Nineteen Twenties and the New Deal in the United States.** One course. *Watson*

**207S, 208S. The Development of Urban America.** The process of urbanization from rural society to the modern city. Two courses. *Decker or A. Scott*

**209, 210. Selected Topics in Afro-American History, 1619-Present.** Critical issues of the collective experience of Afro-Americans with special attention to Black institutional development. Two courses. *Gavins*

**212. Recent Interpretations of United States History.** A course designed to encourage a critical evaluation of major issues in United States history through examination of recent interpretations of key problems. (Open only to history graduate students and seniors doing practice teaching in one of their final two semesters.) One course. *Watson and Staff*

**215-216. The Diplomatic History of the United States.** (Not open to undergraduates who have had History 121-122.) Two courses. *Davis*

**217. Fascism and Its Background.** Emphasis on Italy and Germany, with attention also to France and Eastern Europe. One course. *Maier*

**218. Twentieth-Century Europe.** Social and economic issues: inflation, mass unemployment, and international economy from the gold standard to the present. One course. *Maier*

**221. Problems in the Economic and Social History of Europe, 1200-1700.** One course. *Witt*

**222. Problems in European Intellectual History, 1250-1550.** One course. *Witt*

**223S, 224S. The Old Regime, the Enlightenment, and the French Revolution.** Political, social, and intellectual trends in seventeenth- and eighteenth-century Europe, with emphasis on France and the French Revolution. Two courses.

**227-228. Recent United States History: Major Political and Social Movements.** Two courses. *Chafe*

**229. Recent Interpretations of Modern European History.** A course designed to develop the ability to appraise critical historical issues through the study and discussion of recent interpretations of key historical problems in modern European history. (Open only to history graduate students and seniors doing practice teaching in one of their final two semesters.) One course.

**231S, 232S. Problems in the History of Spain and the Spanish Empire.** Two courses. *TePaske*

**234S. Political Economy of Development: Theories of Change in the Third World.** (Also listed as Political Sciences 234S.) One course. *Bergquist and Valenzuela*

**237S. Europe in the Early Middle Ages.** One course. *Young*

**238S. Europe in the High Middle Ages.** One course. *Young*

- 240. Aspects of Traditional and Modern African Culture.** Introduction to the oral and written literatures and musical and artistic traditions. One course. *Hartwig*
- 241-242. Modernization and Revolution in China.** Two courses. *Dirlik*
- 247. History of Modern India and Pakistan, 1707-1857.** Analysis and interpretation, with special emphasis on social and economic change. One course.
- 248. History of Modern India and Pakistan, 1857 to the Present.** One course.
- 249-250. Social and Intellectual History of the United States.** The interplay of ideas and social practice through the examination of attitudes and institutions in such fields as science and technology, law, learning, and religion. Two courses. *Holley*
- 255S-256S. Problems in African History.** Two courses. *Hartwig*
- 260. Economic History of Japan.** (Also listed as Economics 232.) One course. *Bronfenbrenner*
- 261-262. Problems in Soviet History.** Studies in the background of the Revolution of 1917 and the history and politics of the Soviet state. Two courses. *Lerner*
- 263-264. American Colonial History and the Revolution, 1607-1789.** The founding and institutional development of the English colonies; the background, progress, and results of the Revolution. Two courses. *Wood*
- 265S, 266S. Problems in Modern Latin American History.** Two courses. *Bergquist*
- 267S-268S. From Medieval to Early Modern England.** The intellectual, social, and political problems of transition to modern England, with special emphasis on the English Renaissance. Two courses. *Ferguson*
- 269-270. British History, Seventeenth Century to the Present.** Historiography of social structure and social change: English Revolution, party, the Industrial Revolution, class and class consciousness, Victorianism, and the impact of war in the twentieth century. Two courses. *Cell*
- 272. Poverty in the United States: An Historical Perspective.** (Also listed as Public Policy Studies 272). One course. *Decker*
- 273, 274. Topics in the History of Science.** Critical stages in the evolution of scientific thought. Two courses. *Mauskopf*
- 275S, 276S. Central Europe, 1848-1918.** Conflict between liberalism and authoritarianism, clash of nationalities, diplomatic interaction, emphasizing domestic changes in Germany and Austria-Hungary. Two courses. *Hollyday*
- 277S. The Coming of the Civil War in the United States, 1820-1861.** One course. *Durden*
- 278S. The Civil War in the United States and its Aftermath, 1861-1900.** One course. *Durden*
- 280. Historiography.** Great historians since Herodotus and an examination of recent twentieth-century trends. One course. *Hollyday*
- 283. Political and Social Change in the United States, 1789-1860.** One course. *Nathans*
- 285S, 286S. Oral History.** Research on race relations and civil rights in the

United States in the twentieth century using techniques of oral history. Prerequisite: consent of instructor. Two courses. *Chafe and Goodwyn*

**287-288. History of Modern Japan.** The political, economic, and social development of Japan since 1750; factors contributing to Japan's emergence as a modern state. Two courses. *Stone*

**297S. The British Empire of the Nineteenth Century.** The development of the Empire from the American Revolution to the imperialism that culminated in the South African War. One course. *Preston*

**298S. The Commonwealth in the Twentieth Century.** The origins and evolution of the Commonwealth of Nations and its adjustment in the age of anticolonialism. One course. *Preston*

## SMALL-GROUP LEARNING EXPERIENCES

(For discussion sections, see History 175D, 176D.)

### Tutorial

**189T, 190T. Tutorial in History.** Two courses. *Staff*

### Independent Study

Independent study is usually undertaken by students concurrently with a course or with an instructor with whom they have had a course. Students should submit to the instructor in writing a detailed description of intent in the study. Both the instructor's consent and approval of the Director of Undergraduate Studies are required for enrollment.

**191, 192. Independent Study.** One or two courses each. *Staff*

### Undergraduate Seminars

(See also History 21S, 22S, 150S, 153S, 159S, 183S.)

**165S-166S. Seminar in Selected Topics.** Course content determined by instructor: consent of instructor is required. Two courses. *Staff*

The following seminars offer opportunities for reading and historical investigation in significant problems. Juniors as well as seniors may apply for admission to these courses and are urged to do so if they expect to be candidates for graduation with distinction in history or if they expect to practice-teach in their senior year. All seminars are open to majors and non-majors.

**195A-196A. Renaissance Intellectual History.** Studies in the transformation of European thought between 1300 and 1600. Two courses. *Witt*

**195B-196B. Twentieth-Century Europe.** Two courses. *Maier*

**195C-196C. Problems in the Social and Intellectual History of the United States.** Two courses. *Holley*

**195E-196E. The Age of the American Revolution.** Two courses. *Wood*

**195F. The Coming of the Civil War in the United States, 1820-1861.** One course. *Durden*

196F. **The Civil War in the United States and Its Aftermath, 1861-1900.** One course. *Durden*

195G-196G. **Nationalism and Communism in the Far East.** Two courses. *Dirlik*

195H, 196H. **From Rural to Urban Society in the United States.** (History 195H is also listed as Public Policy Studies 195A.) Two courses. *Decker* or *A. Scott*

195I. **The Emergence of Germany, 1815-1871.** One course. *Hollyday*

196I. **The German Empire and Europe, 1871-1918.** One course. *Hollyday*

195J-196J. **History of International Socialism to the First World War.** Evolution of socialist thought from early nineteenth-century Utopian theory through Marxist and anarchist ideologies; the relationship of socialist parties and leaders to the First and Second Internationals. Two courses. *Miller*

195K-196K. **Social Change in Modern Britain.** Two courses. *Cell*

195L. **Causes of Revolution: Search for a Model.** One course. *Cell*

195M-196M. **Europe and the World Since 1914.** Two courses. *W. Scott*

195N-196N. **The English Renaissance.** Two courses. *Ferguson*

195P-196P. **England in the Ages of the Puritan and American Revolutions.** Two courses. *J. Scott*

195R. **The Age of Newton.** One course. *Mauskopf*

196R. **Science and Society, 1775-1875.** One course. *Mauskopf*

195S-196S. **Processes of Development in Modern Japan, 1800 to the Present.** Two courses. *Stone*

195T-196T. **Problems in the History of Russia Before 1917.** Two courses. *Lerner* or *Miller*

195U-196U. **Social Conflict and Political Change in the United States, 1789-1860.** Two courses. *Nathans*

195W. **Studies in Modern Indian History.** One course.

196W. **Pre-Modern Imperial Systems.** Compares components of the political, social, and economic structures of pre-modern bureaucratic empires, stressing seventeenth- and eighteenth-century India, China, and Iran. One course.

195X-196X. **Problems in Latin American History.** Two courses. *Bergquist* or *TePaske*

195Y-196Y. **Issues in the History of Tropical Africa.** Two courses. *Hartwig*

195Z-196Z. **Problems in Recent United States Diplomatic History.** Two courses. *Davis*

197S-198S. **Senior Honors Seminar.** A course designed to introduce qualified students to advanced methods of historical research and writing and to the appraisal of critical historical issues. Open only to seniors, but not restricted to candidates for graduation with distinction. This course, when taken by a history major, is accompanied by two courses of 195-196 seminars or at the 200-level. In unusual circumstances, with consent of the instructor, coordinator of the senior honors seminar, and Director of Undergraduate Studies, 191-192 may replace the two courses of 195-196 seminars or at the 200-level. Two courses. *Staff*



## Upperclassmen-Graduate Seminars

See History 201S, 202S, 205S, 206S, 207S, 208S, 223S, 224S, 231S, 232S, 237S, 238S, 255S-256S, 265S, 266S, 267S-268S, 275S, 276S, 277S, 278S, 285S-286S, 297S, and 298S.

## DEPARTMENTAL MAJOR

**Prerequisite.** A year sequence of two prerequisite courses in history (21-22, 21S-22S, 53-54, 91-92, 175D-176D), beginning either semester.

**Major Requirements.** Students desiring to major in history elect, in addition to the two prerequisite courses, six courses in the department, including two courses in an undergraduate seminar (195-196, 197S-198S) or on the 200-level. They are urged to register for two consecutive courses at this level, but may take two single-semester courses with consent of both instructors. Students wishing to take advanced courses in the history of the United States are advised to elect History 91-92.

**Foreign Languages.** Majors interested in a particular area of study would benefit from knowledge of the language of that area. Majors who contemplate graduate work are reminded of the requirement of a reading knowledge of one or two foreign languages.

**Majors Planning to Teach.** Majors who plan to teach in secondary schools should consult the Education Department. Rising juniors who intend to practice teach in the senior year should take their 195-196 or 197S-198S seminar or 200-level courses as juniors. Two courses, History 229 in the fall and History 212 in the spring, are scheduled in accelerated sessions to accommodate students who are on campus for half of the semester during the semester they do practice teaching.

**Ancient History.** For additional courses in ancient history which may be taken for credit in history, see the history courses listed in the Department of Classical Studies.

**Honors.** Any student who is qualified (see the section on Honors in this *Bulletin*) may undertake work leading to a degree with distinction in history by applying to the Director of Undergraduate Studies as a candidate. Usually, honors work involves participation in one of the 195-196 seminars during the junior year and selection for the Senior Honors Seminar in the senior year.

## House Courses

See page 42 for information on House Courses.

## Interdisciplinary Courses

101, 102. **Introduction to the Civilizations of Southern Asia.** Hindu, Islamic, and Buddhist foundations, impact of the West, and emergence of the modern nation-states of Southern Asia. First semester: traditional Hindu civilization and Islamic impact on Southern Asia. Second semester: Western influences and the development of modern societies and states in Southern Asia. (Also listed as Anthropology 101, 102; History 193, 194; Political Science 101, 102; and Religion 160, 161.) Two courses. *Apte, Braibanti, Calkins, DiBona, Fox, and Lawrence*

104. **Homo Sapiens and the Marine Environment.** For description see Marine Sciences. One course. *Staff*

153S. **The Insurgent South.** Reconstruction, Populism, and the civil rights era,

each approached from a multidisciplinary perspective. Not open to students who have taken Interdisciplinary Course 199 or History 199. Prerequisite: consent of instructor. (Also listed as History 153S.) One course. *Goodwyn*

**156. The Changing Roles of Men and Women: History and Prospects.** Also listed as Sociology 156.) Half-course. *McElroy, McGee, and O'Barr*

**158. Women and Literature.** Modern women authors including Virginia Woolf, Doris Lessing, and Anais Nin; myths of women in literature and society. Nature of course adapted to the interests of students. This course may be used for distributional requirements in humanities. Prerequisite: consent of instructor. One course. *Staff*

**184. Canada: Problems and Issues of an Advanced Industrial Society.** Federal-provincial relations, economic development, environmental and resource problems, American economic and cultural influences, bilingualism and biculturalism, international relations and aid, defense, military relations with the United States, and the "quest for identity." Some seminars conducted by visiting Canadian specialists. (Also listed as History 184, Economics 184, Political Science 184, and Sociology 184.) One course. *Preston and Visiting Lecturers*

**257S, 258S. Modern East Asia: Introduction to Problems and Literature.** Response of the monarchy to the Western challenge; the Western impact and strains in Chinese society; the disintegrative role of the military in modern China; bureaucracy in modern Japan; the role of women in Japanese society; the potential political impact of the Japanese environmental movement; the Korean student revolution; and response to Western pressure. (Also listed as Political Science 257S, 258S.) Two courses. *McKean*

## Italian

For courses in Italian, see Romance Languages.

## Japanese

For courses in Japanese, see African and Asian Languages.

## Judaic Studies—Cooperative Program at Duke and UNC-Chapel Hill

Associate Professor Meyers (Religion), *Director*; Professor Wintermute (Religion); Associate Professor Bailey (Divinity); Assistant Professors Bland (Religion) and Alt (Germanic Languages and Literature); Instructor Mor (Religion)

A program in Judaic studies may be taken as part of a major in religion, as a supplement to any other major, or under Program II.

For a description of the following courses consult the listings under the specified departments.

### German

171. Yiddish Literature in Translation. *Alt*

181-182. Elementary Yiddish. *Alt*

### Religion

50. The Old Testament. *Staff*

104. The Prophets of the Old Testament. *Wintermute*

- 105. Theology of the Old Testament. *Wintemute*
- 131D. Principles of Archeological Investigation. *Meyers*
- 132D. Palestine in Late Antiquity. *Meyers*
- 133. Foundations of Post-Biblical Judaism. *Meyers*
- 134. Jewish Mysticism. *Bland*
- 135. Jewish Religious Thought. *Bland*
- 136. Contemporary Jewish Thought. *Meyers*
- 137. Jewish Ritual and Theology. *Bland*
- 139. Modern Hebrew. *Mor*
- 195C, 196C. Junior-Senior Seminars: Judaic Studies. *Staff*
- 115-116. (Divinity School) Introduction to Biblical Hebrew. *Bailey*
- 207, 208. (Divinity School) Second Hebrew. *Staff*
- 220. Third Hebrew. *Staff*
- 221. Readings in Hebrew Biblical Commentaries. *Bland*
- 238. Jewish Responses to Christianity. *Bland*
- 244. The Archeology of Palestine in Hellenistic-Roman Times. *Meyers*

Opportunities for independent study are offered in the Department of Religion under 191, 192, 193, 194. Procedures for registration and applications are available in 118 Gray Building.

Special attention is directed to those courses in New Testament which are relevant to the study of Rabbinic Judaism, i.e., Religion 106, 107, 108, 111, and 145 and to the appropriate courses at the University of North Carolina at Chapel Hill.

## Latin

For courses offered in Latin, see Classical Studies.

## Linguistics

Students interested in the study of language as part of their undergraduate program or as preparation for graduate work in linguistics should consult the instructors of the courses listed below. No major is offered in linguistics. The courses may be taken as electives by advanced students, and certain courses serve as related work in several major programs. For descriptions of the following courses see the listings of the specified departments:

### Anthropology

- 107. Introduction to Linguistics. (Also listed as English 107.) *Apte, Butters, or Hull*
- 116. Language, Ethnicity, and New Nations. *Apte*
- 117. Language, Law, and Politics. *O'Barr*
- 119. Language, Culture, and Society. *Apte or Rosen*
- 210. Linguistic Anthropology: Theory. *Apte or Casson*
- 211. Linguistic Anthropology: Ethnography of Communication. *Apte*
- 259. Linguistic Anthropology: Language Acquisition. *Staff*

### English

- 107. Introduction to Linguistics. (Also listed as Anthropology 107.) *Apte, Butters, or Hull*
- 108. Development of the English Language. *Butters*
- 109. Modern English Grammar. *Butters*
- 207. Old English Grammar and Readings. *Nygaard or Reiss*
- 208. History of the English Language. *Nygaard or Reiss*
- 209. Present-Day English. *Butters, Nygaard, or Reiss*

### French

- 210. The Structure of French. *Hull*
- 219. Old French Literature. *Vincent*
- 224. History of the French Language. *Hull*

## German

- 205, 206. Middle High German. *Rosenberg*
- 216. History of the German Language. *Rosenberg*
- 219. Applied Linguistics. *Rosenberg*

## Philosophy

- 103. Symbolic Logic. *Ross*
- 109. Philosophy of Language. *Welsh*

## Psychology

- 134. Psychology of Language. *Robinson*

## Spanish

- 257. History of the Spanish Language. *Garci-Gómez*
- 259. Spanish Phonetics. *Predmore*

## Yiddish

- 181, 182. Elementary Yiddish. *Alt*

# Management Sciences

Professor Keller, *Chairman*; Professor Dickens, *Director of Undergraduate Studies*; Professors Baligh, Blaydon, Cohen, Laughhunn, Lewin, and Peterson; Associate Professors Abdel-khalik, Baker, Battle, Burton, Dellinger, Hughes, and Morse; Assistant Professors Eaker, Espejo, Kessler, Kuhn, Magat, Maier, Scheiner, Taylor, Vander Weide, Westbrook, and Zalkind

The courses offered by the Department of Management Sciences stress conceptual understanding of, and analytical reasoning related to, problems of modern management, and the relationship between the performance of complex organizations and the society in which they operate.

**50. Elementary Theory of Economic Enterprise.** Analysis of the internal resource allocation of the firm, market structures, and capital theory and the mathematical foundations for this analysis. Prerequisite: Mathematics 31. Not open to students who have taken Economics 2 or 52. One course.

**50P. Preceptorial.** Elective preceptorial for students enrolled in Management Sciences 50. *Staff*

**53. Introductory Financial Accounting.** The accounting model of the firm and transactions analysis. Topics include the procedures used to process accounting data, issues in asset valuation and income determination, and financial statement analyses. Prerequisite: Mathematics 31. Corequisite: Management Sciences 50 or equivalent. One course.

**53P. Preceptorial.** Elective preceptorial for students enrolled in Management Science 53.

**110. Probability and Statistics.** Probability theory and distributions. Classical statistical analysis and its application to decision problems. Estimation, hypothesis testing, regression, and correlation analysis. Not open to students who have taken Public Policy Studies 112, Economics 138, Mathematics 53, or Engineering 150. Prerequisite: Mathematics 31. Corequisite: Management Science 50. One course.

**114. Decision Models.** Mathematical models in the analysis of decision problems. Topics include linear algebra, linear programming, and decision analysis; ap-



proaches to the solution of complex problems. Prerequisites: Management Sciences 50, 70, and 110 and computer programming ability. One course.

**116. Stochastic Operations Research Models.** Topics include inventory theory, queuing theory, stochastic processes, Markov chains, reliability, advanced decision analysis, and simulation. Prerequisite: Management Sciences 114 or consent of instructor. One course.

**117. Deterministic Operations Research Models.** Topics include decomposition, non-linear programming, integer programming networks, dynamic programming, game theory. Prerequisite: Management Sciences 114 or consent of instructor. One course.

**120. Analysis of Organizational Behavior.** The structure and behavior of organizations, with special reference to business firms. Topics include rationality, authority, bureaucracy; power, decision-making, informal organization, organization change; effects of technology, culture, and other environmental influences. Prerequisite: Management Sciences 50. One course.

**120P. Preceptorial.** Elective preceptorial for students enrolled in Management Sciences 120. *Staff*

**121. Leadership and Small Groups.** Normative studies of work group formation, maturation, and sanctions. Experiential exercises in leadership and group processes. Prerequisites: Management Sciences 50, 110, and 120 or equivalent. Not open to students who have taken Psychology 147S. One course.

**137. Managerial Accounting.** The use of accounting information by management in short term planning, control, and decision-making in business enterprises. Cost accumulation, cost analysis, cost estimation, the development of standards, introduction to budgeting, and short run decisions. Prerequisite: Management Sciences 53; corequisite: Management Sciences 114. One course.

**141. Legal Environment of the Firm.** The legal environment of business with particular emphasis on the Uniform Commercial Code. Prerequisite: junior standing. One course.

**145. Federal Income Taxation.** Principles of federal income tax laws related to corporations and individuals. Tax planning and the effect of tax law on business decisions will be emphasized. Prerequisite: Management Sciences 53. One course.

**151. Investment Management.** Problems of selecting a portfolio of investments emphasizing the economics of the markets and the tools of analysis. Prerequisite: Management Sciences 50 and 110 or equivalents, or consent of instructor. One course.

**154. Finance.** Problems of financial management of the firm. Cash management, receivables management, short-term financial planning, cost of capital, capital budgeting, dividend policy, lease analysis and long-term financial planning. Prerequisites: Management Sciences 53 and 114 or equivalent. One course.

**161. Marketing Management.** The role of the marketing function in business; product planning, price promotion, and distribution as elements of a total marketing mix. Formal models in solving the marketing mix problem of the firm. Prerequisite: Management Sciences 114. One course.

**171. Production.** An economic and social analysis of designing a production system for an organization, of operating within the designed constraints, and of in-

teractions within the organization and with society. Prerequisites: Management Sciences 53 and 114. One course.

**191, 192. Independent Study.** Directed reading and research. Approval of the instructor and the Director of Undergraduate Studies required.

**193, 194. Independent Study.** Same as 191, 192 but for seniors.

**201S. Market Structure and Performance.** Industrial conduct and performance under various market structures, both in theory and in practice. Evaluation of public policy measures, such as public utility regulation and antitrust action, which are used to improve market performance. Prerequisites: Management Sciences 50 and 110 or consent of instructor. Not open to students who have taken Economics 189 or Economics 198. One course.

**202S. Intermediate Theory of Economic Enterprise.** Competitive market strategies and cooperating decisions, analysis of the efficiency and equilibrium of market structures. Emphasizes the interrelationships of the economic environment and the decision of the enterprise. Prerequisite: Management Sciences 114. One course.

**212S. Seminar in Operations Research.** Topics may include applied operation research, decomposition models of the firm, network analysis, inventory theory, sequencing, or game theory. Prerequisites: Management Sciences 116 and 117 or consent of instructor. One course.

**220S. Administrative Behavior and Organization Design.** Implications of organization structure for the administrator. Various strategies of decomposition of the firm and the interaction of the structural, technical, and social systems. Dysfunctional properties of structure constraining administrative behavior and organizational effectiveness. Prerequisite: Management Sciences 161 or 171. One course.

**231. Intermediate Financial Accounting.** Requirements of investors, auditors, unions, and governments for information about the status and operations of firms and a framework for disclosure of the relevant data. Prerequisite: Management Sciences 53. One course.

**232. Internal Control and Auditing.** The independent auditor's examination of the accounting control system and other evidence as a basis for expressing an opinion on a client's financial statements. Basic audit objectives, standards, ethics, terminology, procedures, and reports. Prerequisites: Management Sciences 137, 231. One course.

**234. Advanced Financial Accounting.** Accounting for and reporting on the diverse activity of multi-product, multi-divisional, multi-national organizations. Organizations with and without profit goals are studied. Prerequisites: Management Sciences 137, 231. One course.

**236S. Selected Topics in Financial Accounting.** Interrelationships between selected topics and issues in accounting and other disciplines. Prerequisites: Management Sciences 137, 231. One course.

**237S. Advanced Managerial Accounting.** Evaluating performance in complex organizations. Transfer pricing, inventory systems, the use of linear programming in developing budgets and capital budgeting. Some aspects of the behavioral consequences of performance measurements. Prerequisites: Management Sciences 137, 231. One course.

**241. Management Strategy.** Structural framework for viewing problems inherent in formulating, implementing and monitoring corporate strategy. Synthesis of

strategic planning process, analysis of the external environment, use of formal models and data bases, and concepts from the functional areas. Prerequisites: Management Sciences 154, 161, and 171 or 137. One course.

**251S. Seminar in Managerial Finance.** Topics to be arranged. Prerequisite: Management Sciences 151. One course.

**261S. Seminar in Marketing.** Topics to be arranged. Prerequisite: Management Sciences 161 or consent of instructor. One course.

**271S. Seminar in Production.** Topics to be arranged. Prerequisite: Management 171. One course.

## DEPARTMENTAL MAJOR

Two baccalaureate degree programs are offered. The Bachelor of Arts degree permits greater flexibility in allowing the student to develop a sound understanding of the area and yet have ample time for study of other areas. The Bachelor of Science degree program provides a greater depth of study for the preprofessional student. Within each degree program two majors are offered: management sciences and management sciences/accounting.

### For the A.B. Degree

*Core Program.* Mathematics 31, Management Sciences 50, 110, 120, 114, and competence in computer programming. A course in macroeconomics is recommended.

*Required Courses—Management Sciences Major.* Four courses in addition to the core offered by the department, three of which must be numbered 116 or 117 or 137 or 154 or above. One of the following economics courses may count for credit in the Management Sciences major: 139, 153, 154, 155, 243, 244.

*Required Courses—Management Sciences/Accounting Major.* Management Sciences 53, in addition to the core, and three additional courses from the 130, 230 series.

### For the B.S. Degree

*Core Program.* Mathematics 31; Management Sciences 50, 53, 110, 114, 120, 154, 161, 241; Economics 51 or 153 or 154; and competence in computer programming.

*Required Courses—Management Sciences Major.* Management Sciences 171 and three electives in the department, including one seminar.

*Required Courses—Management Sciences/Accounting Major.* Management Sciences 137 and three electives from the 230 series. Elective courses are available to provide reasonable preparation for professional certification as a certified public accountant or certified management accountant. See the Director of Undergraduate Studies for a sequence of courses recommended as preparation for certification as a professional accountant.

## Marine Sciences—The University Program

Professor Costlow, *Director*; Professors Bookhout (Zoology) and Pilkey\* (Geology); Associate Professors Barber (Botany and Zoology), C. Bonaventura (Biochemistry),

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\*In residence during summer only.

J. Bonaventura (Biochemistry), Gutknecht (Physiology), Searles\* (Botany), Sullivan (Biochemistry), and Sutherland (Zoology); Assistant Professors Baier (Chemistry), Forward (Zoology), McClay\* (Zoology), and Rosendahl\* (Geology); Research Associate Goll

The interdisciplinary program in the marine sciences makes it possible for qualified juniors and seniors to live and study at the Duke University Marine Laboratory, Beaufort, North Carolina, during the spring semester. The program consists of two courses (104 and 150, 169 or 220) and one seminar, in addition to independent research. A student may continue study at the Marine Laboratory during the summer either by participating in advanced courses or by continuing independent studies initiated during the spring semester.

Applications are to be submitted by October 7 to the Director, Duke University Marine Laboratory, Beaufort, North Carolina 28516, and should include two letters of recommendation, one of which must be from the director of undergraduate studies of the student's major department. A current transcript is also required. Students will be notified of the action of the review committee prior to registration for the spring semester.

## SPRING COURSES AT BEAUFORT

**Homo Sapiens and the Marine Environment.** (Interdisciplinary Course 104.) Economic, legal, medical, political, social, and scientific viewpoints on the effect of society on the marine environment; special emphasis on coastal North Carolina. Lectures and laboratories. One course. *Costlow and Staff*

**Physiology of Marine Animals.** (Zoology 150L.) Comparative physiology including special ecological and behavioral adaptations. Students may not receive credit for both Zoology 150L and 250L. Prerequisites: introductory biology and Chemistry 12. One course. *Forward*

**The Marine Environment.** (Botany 169L, Geology 169, and Zoology 169L.) Interrelationships of the geological, chemical, and biological aspects of the estuarine and oceanic environments. Lectures and laboratories. Prerequisite: Chemistry 12. One course. *Sutherland*

**Independent Study.** (Botany 192, Geology 192, and Zoology 192.) For junior and senior majors with consent of the director of undergraduate studies and the supervising instructor. One and one-half courses. *Staff*

**Adaptations of Organisms to the Marine Environment.** (Biochemistry 220.) Introduction to basic concepts of biochemistry and to variables in the marine environment which evoke adaptive responses. Specific adaptations at the molecular level and biological fitness from a biochemical viewpoint. Laboratory experiments utilize many basic methods of biochemical analysis. Prerequisites of basic biology and chemistry and consent of instructors. One course. *C. Bonaventura and J. Bonaventura*

**Seminar.** (Zoology 296S.) Topics, instructors, and course credits announced each semester. *Staff*

## SUMMER COURSES AT BEAUFORT

The following courses are described in the listings of the specified departments or in the *Bulletin of the Duke University Marine Laboratory*.

**Introduction to Biological Oceanography.** (Zoology 114L.) One and one-half courses. *Rowe (Visiting Summer Faculty)*



**Introductory Geological Oceanography.** (Geology 168.) One and one-half courses. *Goll*

**Invertebrate Zoology.** (Zoology 175L.) One and one-half courses. *Bookhout*

**Marine Ecology.** (Zoology 203L.) One and one-half courses. *Sutherland*

**Introduction to Mathematical Models in Biology.** (Zoology 211.) One and one-half courses. *Monroe*

**Geological Oceanography.** (Geology 205.) One and one-half courses. *Pilkey and Glaeser*

**Marine Phycology** (Botany 211L.) One and one-half courses. *Searles*

**Membrane Physiology and Osmoregulation** (Physiology 212.) One and one-half courses. *Gutknecht and Staff*

**Biological Oceanography.** (Botany 214L and Zoology 214L.) One and one-half courses. *Barber*

**Environmental Oceanography.** (Chemistry 230.) One and one-half courses. *Staff*

**Chemical Oceanography.** (Chemistry 240.) One and one-half courses. *Staff*

**Physiological Ecology of Marine Animals.** (Zoology 250L.) One and one-half courses. *Forward*

**Introduction to Marine Geophysics.** (Geology 250.) One and one-half courses. *Rosendahl*

**Marine Invertebrate Zoology.** (Zoology 274.) One and one-half courses. *Barnes (Visiting Summer Faculty)*

**Comparative and Evolutionary Biochemistry.** (Biochemistry 276.) One and one-half courses. *Sullivan*

**Invertebrate Embryology.** (Zoology 278L.) One and one-half courses. *McClay*

## Mathematics

Professor Warner, *Chairman*; Professor Murray, *Director of Undergraduate Studies*; Assistant Professor L. Smith, *Supervisor of Freshman Instruction*; Professors Allard, Arthur, Carlitz, Reed, Shoenfield, and Weisfeld; Associate Professors Burdick, R. Hodel, Kitchen, Kraines, Moore, Scoville, and D. Smith; Adjunct Associate Professor Chandra; Assistant Professors Butler, Cantor, Katz, Lees, Protter, Reznick, and Wolpert; Instructors Lawrence and Williams; Part-time Instructor M. Hodel

**19. Pre-Calculus Mathematics.** Selected topics in algebra, trigonometry, and analytic geometry. Students with CEEB achievement scores in mathematics below 530 need this skill course before taking Mathematics 31. Prerequisite: two units of college preparatory mathematics. One course. *Staff*

**31. Introductory Calculus.** Limits and continuity; techniques and applications of the differential calculus; the definite integral. Prerequisite: three years of college preparatory mathematics. One course. *Staff*

**32. Introductory Calculus.** Applications of the definite integral; transcendental functions; techniques of integration; infinite sequences and infinite series. (Not

open to students who have had Mathematics 36.) Prerequisite: Mathematics 31. One course. *Staff*

**31P, 32P. Preceptorial.** Elective preceptorial for students enrolled in Mathematics 31 and 32. *Staff*

**31X, 32X. Honors Calculus.** Similar to Mathematics 31 and 32, but more theoretical. Majors in mathematics as well as others who have achievement scores of 760-800 are encouraged to enroll. Occasionally these courses will be offered as seminars. Two courses. *Staff*

**33, 34. Introductory Calculus with Digital Computation.** Introduction to the digital computer, analytical and numerical treatments of limits, differentiation, integration, solution of equations in one variable, elementary transcendental functions, sequences, series, Taylor's formula, applications. Mathematics 33 is prerequisite to Mathematics 34. Two courses. *Staff*

**36. Calculus for the Social Sciences.** Transcendental functions, with special emphasis on the logarithm and exponential functions; techniques of integration; partial differentiation with applications; infinite sequences and infinite series. (Not open to students who have had Mathematics 32.) It will not serve as prerequisite for Mathematics 103. One course. *Staff*

**38. Calculus in the Development of Modern Science.** Mathematical development of topics in the calculus which were central to the scientific revolution; differential equations, Kepler's laws, Newton's scientific achievement, partial differential equations, mathematical models in physics and biology. Intended primarily for students in the humanities. An alternative to Mathematics 32, this course does not satisfy the prerequisites for any course requiring Mathematics 32. Prerequisite: Mathematics 31 or the equivalent. One course. *Staff*

**53. Basic Statistics.** Statistical concepts involved in making inferences, decisions, and predictions from data. Techniques not emphasized. Not open to students who have had Economics 138 or Psychology 117. One course. *Staff*

**103. Intermediate Calculus.** Solid analytic geometry with vectors, partial differentiation, multiple integrals, elementary differential equations, and complex numbers. Prerequisite: Mathematics 32 or 34. One course. *Staff*

**103P. Preceptorial.** Optional preceptorial for students enrolled in Mathematics 103. *Staff*

**104. Linear Algebra and Applications.** Euclidean  $n$ -space, abstract vector spaces, linear transformations and matrix representation, elementary row operations, determinants, eigenvectors and eigenvalues; and applications to the solution of ill-conditioned simultaneous systems. Prerequisite: Mathematics 32 or 34. One course. *Staff*

**104P. Preceptorial.** Elective preceptorial for students enrolled in Mathematics 104. *Staff*

**103X, 104X. Sophomore Honors Calculus.** Similar to Mathematics 103, 104, but more theoretical. Students who take 31X, 32X are encouraged to enroll. Students continuing from 103X should take 104X rather than 104. Two courses. *Staff*

**111. Applied Mathematical Analysis I.** Ordinary differential equations, including linear differential equations of order  $n$ ; partial linear differential equations with constant coefficients; topics in vector calculus; Fourier series. Not open to students who have had Mathematics 131. Prerequisite: Mathematics 103. One course.

**112. Applied Mathematical Analysis II.** Complex variables, residues, conformal mapping, matrices, Laplace and Fourier Transforms and their applications. Prerequisite: Mathematics 103. One course. *Staff*

**126. Introduction to Linear Programming and Game Theory.** Fundamental properties of linear programs; linear inequalities and convex sets; primal simplex method, duality; integer programming; two person and matrix games. Prerequisites: Mathematics 32 or 34 and 10 and 104 or consent of instructor. One course. *Weisfeld*

**128. Number Theory.** Divisibility properties of integers; prime numbers; congruences; quadratic reciprocity; number-theoretic functions; simple continued fractions; rational approximations. Prerequisite: Mathematics 32 or 34 or consent of the instructor. One course. *Staff*

**129. Introduction to Modern Algebra.** Elementary theory of groups, rings, and fields; construction of basic number systems. Prerequisite: Mathematics 104. One course. *Staff*

**131. Elementary Differential Equations.** Solution of differential equations of elementary types; formation and integration of equations arising in applications. Not open to students who have had Mathematics 111. Prerequisite: Mathematics 103. One course. *Staff*

**132S. Qualitative Theory of Ordinary Differential Equations.** Qualitative behavior of general systems of ordinary differential equations, with application to biological and ecological systems, oscillations in biochemistry, electrical networks, and the theory of deterministic epidemics. Prerequisite: Mathematics 131 or 111 or consent of the instructor. One course. *Cantor*

**135, 136. Probability and Statistics.** Permutations and combinations, total and compound probability, Bayes' formula, Bernoulli's theorem, discrete distributions, central values, moments and mathematical expectation, law of large numbers, probabilities in continuum, continuous distributions, sampling distributions, confidence limits, tests of hypotheses, and analysis of variance. Prerequisites: Mathematics 103 for 135; 135 and 104 for 136. Two courses. *Burdick*

**135P, 136P. Preceptorial.** Optional preceptorials for students enrolled in Mathematics 135, 136. *Burdick*

**139, 140. Advanced Calculus.** Differential and integral calculus of functions of several variables; spaces of continuous functions; Fourier series; existence theorems and uniqueness theorems for differential equations; line and surface integrals; Green's theorem and Stokes' theorem; power series and analytic functions. Prerequisites: Mathematics 103 and 104 for 139; 139 for 140. Two courses. *Staff*

**152. List Processing and Data Structures.** (Also listed as Computer Science 152.) One course. *Staff*

**161. Numerical Solution of Ordinary Differential Equations.** Basic existence and uniqueness considerations; algorithmic procedures for step by step integration; stability theory and its limitations; accuracy analysis and numerical procedures for determining it; analogue methods and their accuracy and stability characteristics. Prerequisites: Mathematics 103 and 104. One course. *Murray*

**171S. Elementary Topology.** Basic set theory; metric spaces; topological spaces; continuity; basic topological properties including compactness and connectedness. Prerequisites: Mathematics 103 and 104. One course. *Staff*

**181. Complex Analysis.** Complex numbers, analytic functions, complex integration, Cauchy's theorem, Taylor and Laurent series, theory of residues, argument and maximum principles, conformal mapping. Prerequisite: Mathematics 103. One course. *Staff*

**183. Introduction to Statistical Methods.** Emphasis on the classical techniques of hypothesis testing and point and interval estimation, using the binomial normal,  $t$ ,  $F$ , and chi square distributions. Prerequisite: Mathematics 32 or 34 or consent of the instructor. One course. *Staff*

**187. Introduction to Mathematical Logic.** Propositional calculus, predicate calculus. Godel completeness theorem, applications to formal number theory, incompleteness theorem, additional topics in proof theory or computability. Prerequisites: Mathematics 103 and 104 or Philosophy 103. One course. *Staff*

**191, 192. Independent Study.** Directed reading and research. Admission by approval of instructor and Director of Undergraduate Studies. Two courses. *Staff*

**193, 194. Independent Study.** Same as 191, 192, but for seniors. Two courses. *Staff*

**196S. Seminar in Mathematical Model Building.** Real models, mathematical models, axiom systems as used in model building, deterministic and stochastic models, linear optimization, competition, graphs and networks, growth processes, evaluation of models. Term project: model of a nonmathematical problem. Prerequisite: Mathematics 103 and 104. One course. *D. Smith*

**197S. Seminar in Mathematics.** Primarily intended for juniors and seniors majoring in mathematics. Content of course determined by instructor. Prerequisite: Mathematics 103 and 104. One course. *Staff*

### For Seniors and Graduates

**204. Geometry for Teachers.** Metric and synthetic approaches to plane and solid geometry; affine geometry, and an algebraic model of Euclidean geometry. One course. *Staff*

**206. Introduction to Stochastic Processes.** Elementary theory and application of stochastic process models; Poisson processes, counting processes, discrete parameter Markov chains. Prerequisite: Mathematics 135. One course. *Staff*

**207, 208. Introduction to Algebraic Structures.** Groups, rings, fields; isomorphism theorems; partial and total orderings; characterizations of basic number systems; permutation groups; finitely generated Abelian groups; polynomial rings; principal ideal domains; division and Euclidean algorithms; vector spaces; linear transformations and matrices; bilinear forms; multi-linear algebra; determinants; finite dimensional inner product spaces. Prerequisites: Mathematics 103 and 104 for 207; and 207 for 208. Two courses. *Warner*

**217, 218. Intermediate Analysis.** Elementary point set topology and differential calculus in  $n$ -space; implicit and inverse function theorems; integration theory; differentiable manifolds; differential forms; generalized Stokes' theorem. Prerequisite: Mathematics 103 and 104 for 217; and 217 for 218. Two courses.

**221, 222. Numerical Analysis.** For a description of these courses, see Computer Science 221, 222. Two courses. *Patrick*

**227, 228. Theory of Numbers.\*** Congruences, arithmetic functions, compound moduli, quadratic reciprocity, Gauss sums, quadratic forms, sums of squares. Pre-



requisites: Mathematics 103 and 104 for 227; and 227 for 228 or equivalent. Two courses. *Staff*

**229, 230. Algebraic Numbers.\*** Ideals, unique factorization, divisors of the discriminant, determination of the class number. Prerequisites: Mathematics 207 for 229; and 229 for 230. Two courses. *Carlitz*

**231. Applications of Graph Theory.** Linear graphs, matrix representations, cycle structure, isomorphism, connectivity, independence, planarity, coloring, directed graphs, flows in networks as applied to engineering, management, computer science, urban systems, chemistry, physics, economics, sociology, psychology. Prerequisite: Mathematics 103 and 104 or equivalent. One course. *Staff*

**234. Sample Designs.\*** Methods of constructing and analyzing survey designs; elements of simple random sampling, stratified sampling, multistage sampling; methods of estimation; questionnaire construction; refusal and not-at-homes. Prerequisite: Mathematics 183. One course. *Staff*

**235, 236. Algebra.** Elementary categorical algebra; groups with operators, G-sets structure groups; commutative algebra; principal ring modules; structure of rings and modules; field theory. Prerequisites: Mathematics 208 or equivalent for 235; and 235 for 236. Two courses. *Staff*

**244. Analysis of Variance.** Multiple regression, univariate and multivariate ANOVA, multiple comparisons (Scheffe, Tukey, etc.), factorial designs, analysis of covariance, repeated measurement designs. Prerequisite: Mathematics 183 or equivalent. One course. *Staff*

**245, 246. Combinatorial Analysis.\*** Generating functions, permutations, distributions, partitions, compositions, trees, and networks. Prerequisite: calculus. Two courses. *Carlitz*

**247, 248. Arithmetic of Polynomials.\*** Field theory, detailed study of finite fields, special polynomials and functions, valuation theory, the zeta function. Prerequisites: Mathematics 207 or consent of instructor for 247; and 247 for 248. Two courses. *Carlitz*

**256. Orientation for Applied Mathematics.** Simulation and related notions; relation of science and technology with evolution of mathematics; modern generalizations of the concepts of language, validity, empirical science, and statistical inference. Areas of application for various specific mathematical topics. Prerequisite: Mathematics 103 and 104. One course. *Murray*

**260. Design of Experiments.** Factorial and fractional factorial designs, confounding, balanced and partially balanced block designs, response surface methodology, method of steepest ascent, comparison of criteria for optimality of design. Prerequisite: Mathematics 136. One course. *Burdick*

**262. Non-Parametric Statistics.\*** A study of statistical tests in which no assumption about the underlying distribution is made; single and multiple sample tests for nominal and ordinal scales; non-parametric measures of correlation, efficiency of tests. Prerequisite: Mathematics 136 or consent of instructor. One course. *Staff*

**265, 266. Homological Algebra and its Applications.** Categorical algebra; derived categories and homology; sheaves and their cohomology; applications to

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\*Offered on demand.

smooth manifolds and to complex manifolds; preschemes and schemes and their local cohomology. Prerequisites: Mathematics 236 and 271 or consent of instructor. Two courses. *Weisfeld*

**268. Mathematical Foundations of General Relativity.** Review of special relativity, the structure of Lorentz manifolds, curvature tensors and geodesics, the momentum-energy tensor and the Einstein field equations, the Schwarzschild solution and gravitational collapse. Prerequisite: Mathematics 104 or 111, and Physics 42, or consent of instructor. (Also listed as Physics 268.) One course. *Cantor*

**269, 270. Recursive Function Theory.** Basic properties, enumeration theorems, hierarchies, recursive functions of higher types, generalized recursion theory; applications. Prerequisite: Mathematics 187 or consent of instructor. Two courses. *Shoenfield*

**271. Point Set Topology.** Basic topological properties, including compactness, connectedness, separation axioms, and countability properties; metric spaces; product and function spaces. Prerequisite: Mathematics 139 or equivalent. One course. *Staff*

**272. Introductory Algebraic Topology.** Fundamental group and covering spaces; homology groups of cell complexes; classification of compact surfaces; the cohomology ring and Poincaré duality for manifolds. Prerequisite: Mathematics 271. One course. *Staff*

**273. Algebraic Topology.** Fibrations, confibrations and Puppe sequences; homology, cohomology and homotopy theories; Hurewicz isomorphisms theorem; Brown representation theorem; generalized cohomology theories. Prerequisite: Mathematics 272. One course. *Staff*

**274. Geometric Topology.** Handle decomposition of manifolds, isotopy extension theorem; geometric and algebraic intersection numbers; Whitehead torsion and the s cobordism theorem. Prerequisite: Mathematics 272. One course. *Staff*

**275, 276. Probability.** Foundations of probability; random variables; distributions; central limit problem; law of large numbers; limit and ergodic theorems. Prerequisites: Mathematics 291 or consent of instructor. Two courses. *Staff*

**284. Least Squares Analysis of Linear Models.** General linear models; geometrical interpretations; multiple regression; one-way and multi-way analysis of variance; fixed, random, and mixed models; experimental design models; analysis of covariance; introduction to nonlinear models. Prerequisite: Mathematics 136. One course. *Burdick*

**285. Applied Mathematical Methods I.** Heat equation, wave equation, separation of variables, Fourier series, introduction to Hilbert space, Fourier transform, potential theory; complex variables, residues. Prerequisite: Mathematics 103 and 104. One course. *Reed*

**286. Applied Mathematical Methods II.** Eigenvalue problems, integral equations, Fredholm alternative, bounded linear transformations on Hilbert space, applications to partial differential equations, techniques for approximating eigenvalues. Prerequisites: Mathematics 103 and 104. One course. *Reed*

**287, 288. Foundations of Mathematics.\*** Propositional calculus, predicate calculus, axiomatized number theory. Gödel completeness and incompleteness theorems. Recursive functions; hierarchies; constructive ordinals. Set theory; consistency of the axiom of choice. Prerequisite: Mathematics 208 or Philosophy 103, or consent of instructor. (Also listed as Philosophy 287, 288.) Two courses. *Shoenfield*

**289. Mathematical Methods in Quantum Mechanics.** Hilbert space, self-adjoint operators, the mathematical model of quantum mechanics, commutation relations, spectral analysis of Hamiltonians, time dependent scattering theory, theory of group representations. Prerequisites: Mathematics 285, 286 or the equivalent. One course. *Reed*

**290. Stochastic Processes.** Foundations and probabilistic structure of stochastic processes; sample function properties, processes with finite second-order moments, stationary processes; representations. Prerequisite: Mathematics 275. One course. *Staff*

**291, 292. Analysis I, II.** Measure and integration theory; introduction to functional analysis; theory of analytic functions. Prerequisite: Mathematics 218 or 140, or consent of instructor. Two courses. *Staff*

**293. Multivariate Statistics.** Basic multinormal distribution theory, the multivariate general linear model including the use of Hotelling's  $T^2$  statistic and the Roy union-intersection principle, principal components, canonical analysis, and factor analysis. Prerequisite: Mathematics 284 or consent of instructor. One course.

**295. Mathematical Foundations of Statistical Inference.\*** Inference-theoretic approach to hypothesis testing, decision-making, and estimation; Neyman-Pearson fundamental lemma; uniformly most powerful tests; Fisher's information and sufficiency; invariance and unbiasedness. Prerequisite: Mathematics 275 or consent of the instructor. One course. *Staff*

**297, 298. Axiomatic Set Theory.** Statement and development of Zermelo-Fraenkel axioms. Consistency and independence problems. New axioms and their consequences. Prerequisite: consent of instructor. Two courses. *Shoenfield*

## DEPARTMENTAL MAJOR

*Prerequisites.* Mathematics 31, 32.

*Major Requirements.* Mathematics 103, 104; and six additional courses in mathematics numbered above 100 which must include one of the following year sequences: Mathematics 139, 140; Mathematics 207, 208; or Mathematics 217, 218. Mathematics 183 and 244 may not be counted among the six courses, and at most two of the following four courses may be counted: 152, 221, 222, 223.

It is recommended that majors take a one year sequence in a natural science other than mathematics. For a student considering graduate study in mathematics, a reading knowledge of two foreign languages (often French, German, or Russian) is most desirable.

## Medicine, School of—Basic Science Courses Open to Undergraduates

Qualified students in arts and sciences may select courses from the following offered by the graduate departments associated with the School of Medicine. A major is not offered to undergraduates in any of the departments listed below. For permission to register for these courses and for further information, see Associate Professor Counce (Anatomy); Assistant Professor Richardson (Biochemistry); Assistant Professor Vanaman (Microbiology and Immunology); and Associate Professor Padilla (Physiology and Pharmacology). The following courses are described in the *Bulletin of the Graduate School*.

## ANATOMY

**151. Anatomy of the Lower Extremities as it Relates to Locomotion.** One course. *Bassett*

**193, 194. Independent Study.** Open to qualified juniors and seniors with written consent of instructor. Two courses. *Staff*

**212. Cellular Endocrinology.** Prerequisite: consent of instructor. Minimum, 5. One course. *Fletcher*

**215. Contractile Processes.** Prerequisite: consent of instructor. (Also listed as Physiology 216.) One course. *Anderson, Jöbsis, Johnson, and Reedy*

**219. Molecular and Cellular Bases of Development and Differentiation.** Prerequisite: consent of instructor. One course. *Counce, Johnson, Kaufman, McCarty, Padilla*

**231. Human Evolution.** Prerequisite: Anthropology 93 or equivalent. (Also listed as Anthropology 231.) One course. *Cartmill*

**240. Mechanisms of Biological Motility.** Prerequisite: written consent of instructor. One course. *Adelman*

**264. Mammalian Embryology and Developmental Anatomy.** Prerequisites: one year of zoology and consent of instructor. One course. *Duke*

**280. Structure and Assembly of Macromolecules.** Prerequisites: cytology or equivalent, and consent of instructor. One course. *Corless, Erickson, Longley, Moses, Reedy, and Robertson*

**286. The Light Microscope, the Electron Microscope and X-ray Diffraction in Biology.** Prerequisites: cytology or equivalent; calculus; and one year each of physics and general chemistry; consent of instructor. One course. *Corless, Erickson, Longley, Moses, Reedy, and Robertson.*

**288S. The Cell in Development and Heredity.** Prerequisites: genetics or cell biology and consent of instructor. Half-course. *Counce*

## BIOCHEMISTRY

**209-210. Independent Study.** One or two courses by arrangement. *Staff*

**216. Molecular Genetics.** Prerequisites: introductory courses in biochemistry and genetics. (Also listed under Genetics.) One course. *Guild and Staff*

**220. Adaptations of Organisms to the Marine Environment.** One course. (Given at Beaufort.) *C. Bonaventura and J. Bonaventura*

**248. Introductory Biochemistry.** Prerequisites: Chemistry 151, one year of college physics (second semester may be concurrent), and Mathematics 32, consent of instructors. (Also listed as Botany 248.) One course. *Staff*

**276. Comparative and Evolutionary Biochemistry.** (Also listed under Marine Sciences.) One and one-half courses. (Given at Beaufort.) *Sullivan*

**291. Physical Biochemistry.** Prerequisite: Chemistry 161-162 or equivalent. One course. *Kim, Reynolds, Richardson, and Tanford*

**292. Proteins and Enzymes.** One course. *Fridovich, Hill, Rajagopalan, and Richardson*



**297. Intermediary Metabolism.** One course. *Bell, Greene, Kirshner, and Siegel*

## **MICROBIOLOGY AND IMMUNOLOGY**

**209-210. Independent Study.** A laboratory or library project. One or two courses by arrangement. *Staff*

**221. Medical Microbiology.** Prerequisite: consent of instructor. One course. *Joklik and Staff*

**221L. Medical Microbiology.** Prerequisite: consent of instructor. One and one-half courses. *Joklik and Staff*

**233. Microbiology.** (Also listed as Botany 233.) One course. *Burns, Dawson, Joklik, and Willett*

## **PHYSIOLOGY AND PHARMACOLOGY**

**204. Introduction to Modern Physiology.** Prerequisites: at least one year of college physics and college biology, calculus, and organic chemistry (physical chemistry is strongly recommended). One course. *Blum and Staff*

**208. Respiratory System in Health and Disease.** Half-course. *Kylstra, Saltzman, and Salzano*

**212. Marine Membrane Physiology.** (Also listed under Marine Sciences—given at Beaufort.) One and one-half courses. *Gutknecht and Staff*

**215. Topics in Developmental Physiology.** Half-course. *Lieberman, Mendell and Padilla*

**216. Contractile Processes.** Prerequisite: consent of instructor. (Also listed as Anatomy 215.) One course. *Anderson, Jöbsis, Johnson, and Reedy*

**217. Membrane Transport.** Half-course. *Hall, Lauf, Mandel, and Simon*

**222. Marine Electrobiolgy.** Prerequisite: consent of instructor. (Given at Beaufort.) One and one-half courses. *Wachtel and Wohlbarsht*

**230. Molecular and Cellular Basis of Development.** One course. *Padilla and Staff*

**230S. Seminar.** Optional seminar offered in conjunction with Physiology 230. Half-course. *Padilla and Staff*

**252. Cellular and Chemical Pharmacology.** One course. *Ottolenghi and Staff*

**254. Mammalian Toxicology.** One course. *Menzel and Staff*

**256. Human Nutrition.** Half-course. *Menzel*

## **Medieval and Renaissance Studies Program**

Professor Mahoney, *Chairman of the Committee on Medieval and Renaissance Studies*

The Program in Medieval and Renaissance Studies, an interdisciplinary major, is designed to provide the student with a well-rounded understanding of the historical, cultural, and social forces that shaped the Medieval and Renaissance periods. The program is divided into four areas of study: fine arts (art and music); his-

tory; language and literature (French, German, Greek, Italian, Latin, and Spanish); and philosophy-religion.

A major consists of at least eight courses drawn from the non-introductory courses of the four areas of study, including three courses in each of the two areas. Besides the courses specifically listed (under departmental headings) in the Medieval and Renaissance periods, provision may be made for independent study in any of the four areas. Each program is tailored to the needs and interests of the student under the supervision of a committee consisting of faculty members from appropriate departments.

After discussion with the Chairman of the Committee on Medieval and Renaissance Studies, the student submits a provisional program of study outlining special interdisciplinary interests. Normally the program is planned well before the end of the sophomore year to allow time to acquire a working knowledge of languages pertinent to specific interests.

The courses listed below are among those now available for the fulfillment of the major prerequisites and requirements. They are described under the listings of the specified departments.

#### DEPARTMENT OF ART

- 133. Medieval Architecture. *Sunderland*
- 134. Medieval Painting and Sculpture. *Sunderland*
- 135, 136. Art of Northern Europe in the Fifteenth and Sixteenth Centuries. *Mueller*
- 137, 138. Italian Renaissance Art. *Jenkins*
- 144. Renaissance and Baroque Architecture. *Sunderland*
- 233. Early Medieval Architecture. *Sunderland*
- 237. French Renaissance Art. *Jenkins*

#### DEPARTMENT OF CLASSICAL STUDIES

##### Latin

- 87, 88. Sight Reading in Classical, Medieval, and Renaissance Latin. *Staff*
- 221. Medieval Latin I. *Newton*
- 222. Medieval Latin II. *Newton*

##### Classical Studies

- 117. Ancient Mythographers. *Newton*

#### DEPARTMENT OF ENGLISH

- 112. English Literature of the Middle Ages. *Reiss*
- 113. Chaucer. *DeNeef, Nygard, Reiss, or Schwartz*
- 121. English Literature of the Sixteenth Century. *DeNeef or Schwartz*
- 123, 124. Shakespeare. *DeNeef, Jones, Schwartz, or Williams*
- 125. English Literature of the Early Seventeenth Century. *DeNeef*
- 127. Milton. *DeNeef or Price*
- 129. English Drama from the Middle Ages through the Eighteenth Century. *Clum or Reardon*
- 207. Old English Grammar and Readings. *Nygard or Reiss*
- 208. History of the English Language. *Nygard or Reiss*
- 210. Old English Literary Tradition. *Nygard or Reiss*
- 212. Middle English Literary Tradition. *Nygard or Reiss*
- 215. Chaucer. *The Canterbury Tales*. *Nygard or Reiss*
- 216. Chaucer. *Troilus and Criseyde* and the minor poems. *Nygard or Reiss*
- 221. English Prose and Poetry of the Sixteenth Century. *DeNeef*
- 223. Spenser. *DeNeef*
- 224. Shakespeare. *Williams*
- 225, 226. Tudor and Stuart Drama, 1500-1642. *Randall*
- 229, 230. English Literature of the Seventeenth Century. *DeNeef, Jackson, Randall, or Williams*
- 232. Milton. *DeNeef*

## DEPARTMENT OF GERMANIC LANGUAGES AND LITERATURE

- 205, 206. Middle High German. *Rosenberg*
- 215S. Seventeenth-Century Literature. *Borchardt*
- 216. History of the German Language. *Rosenberg*
- 217S. Renaissance and Reformation Literature. *Borchardt*

## DEPARTMENT OF HISTORY

- 103. The Economic, Social, and Political Institutions of Europe, 1250-1600. *Witt*
- 104. The Intellectual Life of Europe, 1250-1600. *Witt*
- 105. Political and Constitutional History of England. *J. Scott*
- 107. Social and Cultural History of England. *Ferguson*
- 133. Medieval Europe, 300-1000 A.D. *Young*
- 134. Medieval Europe, 1000-1400 A.D. *Young*
- 154. Medieval England. *Young*
- 173. History of Spain and the Spanish Empire from Late Medieval Times. *TePaske*
- 195A-196A. Renaissance Intellectual History. *Witt*
- 195N-196N. The English Renaissance. *Ferguson*
- 221. Problems in the Economic and Social History of Europe, 1200-1700. *Witt*
- 222. Problems in European Intellectual History, 1250-1550. *Witt*
- 237S. Europe in the Early Middle Ages. *Young*
- 238S. Europe in the High Middle Ages. *Young*
- 267S, 268S. From Medieval to Early Modern England. *Ferguson*

## DEPARTMENT OF MUSIC

- 159S. Music History IV: History of Music to 1600. *Kirkendale and Tirro*
- 166S. The Renaissance Madrigal. *Saville*

## DEPARTMENT OF PHILOSOPHY

- 119. Medieval Philosophy. *Mahoney*
- 120. Late Medieval and Renaissance Philosophy. *Mahoney*
- 218. Medieval Philosophy. *Mahoney*

## DEPARTMENT OF RELIGION

- 135. Jewish Religious Thought. *Bland*

## DEPARTMENT OF ROMANCE LANGUAGES

### French

- 106S. Montaigne. *Tetel*
- 114S. The Sixteenth Century. *Tetel or Vincent*
- 117S. Masterpieces of French Medieval Literature. *Ripley*
- 119. French Drama of the Seventeenth Century. *Melzer*
- 213, 214. French Literature of the Seventeenth Century. *Melzer*
- 219. Old French Literature. *Vincent*
- 225, 226. French Prose of the Sixteenth Century. *Tetel*

### Italian

- 141. Masterworks of Italian Literature in English Translation. *Caserta*
- 183. Readings in Italian Literature. *Caserta*
- 284. Dante. *Fowlie*
- 285. Dante. *Caserta*
- 288. The Renaissance. *Tetel*

### Spanish

- 117S. Spanish Traditional Poetry. *Garci-Gómez*
- 161. Spanish Literature of the Renaissance and the Baroque. *Miller or Wardropper*
- 167. Cervantes. *Predmore*
- 170. The Picaresque Novel. *Garci-Gómez*
- 251. The Origins of Spanish Prose Fiction. *Wardropper*
- 252. Spanish Lyric Poetry Before 1700. *Wardropper*

253. The Origins of the Spanish Theater. *Wardropper*  
 257. History of the Spanish Language. *Garci-Gómez*  
 258. Medieval Literature. *Garci-Gómez*  
 265. Cervantes. *Predmore or Wardropper*  
 266. Drama of the Golden Age. *Wardropper*

## Romance Languages

124. Continental Humanism. *Tetel*

## Music

Associate Professor Tirro, *Chairman*; Assistant Professor Henry, *Director of Undergraduate Studies*; Professors Bone, Bryan, Douglass, Hamilton, Hanks, Kirkendale, Mueller, and Withers; Associate Professor Saville; Resident Artist Ciompi; Lecturers Sharon and Smith; Visiting Lecturers Provine and Trowbridge; Staff Associates Erdberg, Evans, Lail, Otto, Parkins, Phelps, Plumb, Posner, Raimi, Ruggero, D. Smith, and Turner; Artist Associates Bergstone, Cubbage, Dunigan, B. Fecteau, Listokin, Mizesko, Popkin, Robinson, and Stewart; Librarian Hammond

## THEORY AND COMPOSITION

**7-8. Dictation and Sight-Singing.** Techniques of aural analysis and development of sight-reading skills. To be taken concurrently with Music 65, 66, or 65X, 66X. Skill courses. Half-course each semester. *Plumb*

**36. Acoustics and Music.** Physical principles underlying musical instruments, room acoustics, and the human ear. Analysis, reproduction, and synthesis of musical sounds. No previous knowledge of physics necessary. (Also listed as Physics 36.) One course. *Lawson*

**65. Fundamentals of Music Theory.** Physical properties of sound; principles of diatonic tonal organization; melodic and harmonic constructions; elementary counterpoint and figured bass. Skill course. Prerequisite: basic knowledge of musical notation and vocabulary. To be taken concurrently with Music 7. One course. *Staff*

**66. Tonal Harmony.** Harmonic language of eighteenth- and nineteenth-century classicism; functional chromaticism, sectional forms. Concurrent registration in Music 8 is required. Prerequisites: Music 65 and 7. One course. *Staff*

**65X. Fundamentals of Music Theory.** Same as Music 65, but for music majors or those planning to major in music. One course. *Staff*

**66X. Tonal Harmony.** Same as 66 but for music majors or those planning to major in music. Prerequisites: Music 65X and 7. One course. *Staff*

**67S, 68S. Composition I.** Composing original music in smaller forms for voice, piano, and other instruments. Studies in compositional techniques. Prerequisite: Music 65X, 66X, or consent of instructor. Two courses. *Hamilton*

**107-108. Keyboard Theory.** Harmonic principles of tonal music applied to the keyboard; score reading, figured bass, melodic harmonization, modulation, transposition. To be taken concurrently with Music 115-116. Skill course. Prerequisites: Music 65X-66X, 7-8, and keyboard proficiency. Half-course each semester. *Parkins*

**115S. Modal Counterpoint.** Polyphonic practice of the fifteenth and sixteenth centuries; sacred and secular music. To be taken concurrently with Music 107. Prerequisite: Music 7-8, 65X, 66X. One course. *Tirro*



**116S. Tonal Counterpoint.** Polyphonic practice of the seventeenth and eighteenth centuries; sacred and secular music. To be taken concurrently with Music 108. Prerequisite: Music 107, 115S. One course. *Tirro*

**117S, 118S. Music Theory III: Composition and Analysis.** The development of technical and expressive means in various media and styles. Original instrumental or choral work required. Prerequisites: Music 116S, 139, 158, or consent of instructor. One course. *Hamilton*

**122. Orchestration.** Characteristics and transpositions of the instruments. Scoring for symphony orchestra, concert band, and string, woodwind, brass, and percussion ensembles from pre-existing piano scores, or the student's original compositions. Prerequisite: Music 116S. One course. *Bryan*

**130T, 131T. Performance Practice (Organ) I, II.** Analytical and practical study of organ compositions from various epochs. Registration, fingering, pedaling, ornamentation, touch, and *notes inégales* as described in ancient theoretical treatises and comments of composers. Paper and performances required. Prerequisite: One year of organ instruction at Duke or the equivalent, and consent of instructor. Music 130T is prerequisite to 131T. Two courses. *Douglass*

**132T, 133T. Performance Practice (Organ) III, IV.** Prerequisite: Music 131T for 132T, 132T for 133T. Two courses. *Douglass*

## HISTORY AND LITERATURE

**125. Masterworks of Music.** Historical, biographical, and analytical study of works by major composers of the seventeenth through the twentieth centuries. One course. *Bone, Bryan, Henry, Mueller, or Saville*

**138. East Asian Music.** Traditional music of China, Korea, and Japan, including historical, sociological, and aesthetic considerations. Professional and folk music. Instruction in simple types of East Asian music on native instruments. One course. *Provine*

**139. Twentieth-Century Music.** Influential creative stylistic developments in music of the present century. A critical survey of works by Bartok, Berg, Schoenberg, Stravinsky, and Webern as a means of establishing a relative standard of values for subsequent independent exploration. Prerequisite: a one-year course in music theory or literature, or consent of instructor. One course. *Hamilton and Mueller*

**156S. Music History I: History of Music from 1600 to 1750.** Prerequisites: Music 7-8, 65X, or consent of instructor. One course. *Saville or Kirkendale*

**157S. Music History II: History of Music from 1750 to 1830.** Prerequisites: Music 7-8, 65, or consent of instructor. One course. *Bryan or Kirkendale*

**158S. Music History III: History of Music from 1830 to 1910.** Prerequisites: Music 7-8, 65, or consent of instructor. One course. *Hamilton and Mueller*

**159S. Music History IV: History of Music to 1600.** Prerequisite: Music 7-8, 65, and two courses in music history, or consent of instructor. One course. *Kirkendale or Tirro*

**160. History of the Organ and Its Literature.** Historical survey of the organ from about 1450 to 1950, emphasizing development of the major national styles of building and composition; historical roots of the Flentrop organ. Prerequisite: one course in music theory or literature or consent of instructor. One course. *Douglass*

**161. Medieval Music.** Medieval styles and concepts represented in different vocal and instrumental genres; the composers and the poets and their historical and artistic environment. Prerequisite: one course in music theory or literature, or consent of the instructor. One course. *Staff*

**163. Music in the Eighteenth Century.** Baroque, Rococo, and Classical styles and concepts represented in different instrumental and vocal genres; the composers and their historical and artistic environments. Prerequisite: one course in music theory or literature, or consent of instructor. One course. *Bryan*

**164. Music in the Nineteenth Century.** Romantic and post-romantic music; its relation to the artistic and literary movements of the century. Prerequisite: one course in music theory or literature, or consent of instructor. One course. *Mueller*

**165. Opera Literature.** History of the operatic idea from the Florentine Camerata in the late sixteenth century to the present. Relationship of music and text; opera as social commentary; changing forms and styles. One course. *Saville*

**166S. The Renaissance Madrigal.** History of the Italian madrigal and related forms from fourteenth-century Ars Nova through the Renaissance and into the early Baroque periods. Consideration of musical, poetic, and cultural interrelationships. Prerequisite: ability to read music. One course. *Saville*

**174. Introduction to Jazz.** A multidisciplinary survey for non-majors; examines musical, aesthetic, sociological, and historical aspects of jazz. One course. *Tirro*

## INDEPENDENT STUDY AND SEMINARS

Admission to these courses will be subject to the approval of the Director of Undergraduate Studies and the instructor. The instructor and course content will be established in accordance with the individual student's interests and capacities.

**179, 180. Independent Study in Musical Performance.\*** Open only to sophomores possessing an exceptional technical and interpretive command of a musical medium. Prerequisites: previous registration in private instruction in applied music at Duke, audition, and consent of instructor. Two courses. *Staff*

**181, 182. Independent Study in Musical Performance.\*** Same as 179, 180, but for juniors. Two courses. *Staff*

**183, 184. Independent Study in Musical Performance.\*** Same as 179, 180, but for seniors. Two courses. *Staff*

**185S, 186S. Seminar in Music.** Primarily for junior and senior music majors. Topics to be announced. Prerequisite: consent of instructor. Two courses. *Staff*

**191, 192. Independent Study.** Directed reading, research, and musical analysis within a prescribed area of musical literature. Open only to qualified students in the junior year, by consent of the department. One or two courses. *Staff*

**193, 194. Independent Study.** Same as 191, 192, but for seniors. One or two courses. *Staff*

**195S. Introduction to Music Research.** Library sources, historical methods, and the history of musical scholarship. Preparation for honors papers, but not restricted to candidates for graduation with distinction. Prerequisite: consent of instructor. One course. *Kirkendale*

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\*The schedule of fees for private lessons as published on page 187 is applicable to courses 179, 180, 181, 182, 183, 184.

**196S. Seminar in Musicology.** Specialized historical research on a topic to be arranged. Prerequisite: Music 195S or consent of instructor. One course. *Kirkendale*

## MUSIC EDUCATION AND PEDAGOGY

**57S, 58S, 59S, 60S. Vocal Diction.** Problems of diction for the singer. Study of standard pronunciation with special emphasis on phonetics in Italian, English, German, and French. Four half-courses. *Hanks and Redding*

**128. Instrumental Conducting.** Development of techniques of conducting instrumental ensembles with emphasis on orchestral repertoire. Score-reading and analysis, principles of interpretation, and practical conducting experience. Prerequisite: Music 116S or consent of instructor. One course. *Bone*

**129. Choral Conducting.** Development of techniques of conducting vocal repertoire, ranging from church anthems to large-scale works. Score-reading and analysis, principles of interpretation, and practical conducting experience. Prerequisite: Music 116S or consent of instructor. One course. *Bone or B. Smith*

**151. Public School Music Education (Elementary).** Basic musical skills, music theory and reading; song literature; rhythmic activities; listening; instruction on tonettes, recorders, autoharp, bells, selected percussion instruments, and piano chording. Half-course. *Otto*

**152. Public School Music Education II (Elementary).** Continuation of Music 151 with emphasis on music appreciation as it pertains to social studies in public schools. Study and analysis of key words in music literature. Prerequisites: Music 151 or consent of instructor. Half-course. *Otto*

## APPLIED MUSIC

The study of applied music concerns the understanding of music literature through performance. Private instruction is offered in instruments and voice. Class instruction is offered in small and large ensembles. Students must arrange an audition with the instructor prior to registration, either in person or by tape recording. All courses may be repeated for credit. Not more than two ensembles may be taken concurrently for credit.

### Instruction: 1/2 hour, quarter course credit

- 80. Piano. *Evans, Phelps, Ruggero, Sharon, D. Smith, Turner, or Withers*
- 81. Strings. *Ciampi, Erdberg, Mueller, Plumb, or Raimi*
- 82. Woodwinds. *Dunigan, B. Fecteau, Henry, Listokin, Popkin, or Robinson*
- 83. Brass. *Bergstone, Bryan, Mizesko, or Stewart*
- 84. Percussion. *Staff*
- 85. Voice. *Hanks, Lail, or Posner*
- 86. Organ. *Douglass or Parkins*
- 88. Class Piano. *Staff*

### Instruction: 1 hour, half-course credit

- 90. Piano. *Evans, Phelps, Ruggero, Sharon, D. Smith, Turner, or Withers*
- 91. Strings. *Ciampi, Erdberg, Mueller, Plumb, or Raimi*
- 92. Woodwinds. *Dunigan, B. Fecteau, Henry, Listokin, Popkin, or Robinson*
- 93. Brass. *Bergstone, Bryan, Mizesko, or Stewart*
- 94. Percussion. *Staff*
- 95. Voice. *Hanks, Lail, or Posner*
- 96. Organ. *Douglass or Parkins*



**Ensemble Classes: quarter-course credit; pass/fail**

- 100. Symphony Orchestra. *Bone*
- 101. Wind Symphony. *Bryan*
- 102. Marching Band. *Henry*
- 103. Jazz Ensemble. *Staff*
- 104. String Ensemble. *Staff*
- 105. Wind Ensemble. *Staff*
- 106. Piano Ensemble. *Staff*
- 109. Chancel Singers. *Smith*
- 110. Collegium Musicum. *Tirro*
- 111. Opera Workshop. *Hanks*
- 112. Chapel Choir. *Smith*
- 113. Chorale. *Smith*

**Credit in Applied Music.** (Skill courses—credit not applicable to distributional requirements.)\* Credit for instruction in courses below 100 is granted on the basis of a half-course per semester for one hour of private instruction per week and a minimum of six hours practice weekly; or a half-course per year for one-half hour of private instruction, or one period of class study, and a minimum of six hours practice per week. An additional weekly class meeting for performance and criticism may be required by the instructor without additional credit. Credit for instruction in courses above 100 is granted on the basis of a half-course per year for one rehearsal period of instruction and a minimum of three hours practice per week.

**Fees.** Students are charged for all applied music media below 100. Fees are

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\*Subject to instructor's approval, a student at an advanced level in applied music may take courses for tutorial and distributional requirements. These courses shall be designated by adding a *T* to the appropriate course number. Students who have not reached an advanced level will continue to take the regular applied music courses.



payable to the Bursar's Office upon notification from that office at the beginning of each semester as follows:

One 1/2 hour private lesson per week for one semester .....	\$60.00
Two 1/2 hour private lessons per week or one 1-hour private lesson per week for one semester .....	\$120.00
One 1-hour class lesson per week for one semester .....	\$35.00
No charge is made for practice room facilities.	
These fees are not refundable after the final drop/add day.	

DEPARTMENTAL MAJOR

*Prerequisites.* Music 7-8, 65X, 66X, 107-108, and one year of applied music study in instrument or voice. Any or all of these may be exempted through demonstration of proficiency by examination and/or audition.

*Major Requirements.* Music 115S, 116S, 156S, 157S, 158S, 159S, and one additional elective course in the department.

*Honors.* Students who are qualified (see section on Honors in this *Bulletin*) may undertake work leading to graduation with distinction in music by application to the Director of Undergraduate Studies. In addition to meeting the normal requirements of a major in the department, honors work usually involves participation in an appropriate senior seminar and/or independent study. It must culminate in a paper, historical or analytical, either full length by itself or somewhat more concise if offered in conjunction with a recital or composition. The paper must be approved by a faculty committee.

Naval Science

For courses in Naval Science, see *Reserve Officers Training Program*.

Philosophy

Professor Golding, *Chairman*; Assistant Professor Ross, *Director of Undergraduate Studies*; Professors Peach and Welsh; Associate Professors Mahoney, Roberts, and Sanford; Visiting Assistant Professors Bamford and Boudreaux

The undergraduate program in the Department of Philosophy is designed to acquaint the students with the content and the structure of philosophical theory in various areas. Discussion is encouraged so that the student can engage actively in the philosophical examination of problems.

Course offerings fall into two general categories: the systematic and the historical. In a systematic treatment, the organization of a course is primarily in terms of the problems presented by the subject matter of that course, as in logic, ethics, and metaphysics. In historical courses, attention is directed more to the order of development in the thought of a particular philosopher (Plato, Aristotle, Kant), or in a historical period. In all courses, reading of the works of philosophers will acquaint the students with the important and influential contributions to the definition and solution of philosophical issues.

The problems raised in philosophy in respect to the various fields of the arts and sciences involve questions which are not normally given attention in those particular disciplines. In the consideration of such problems, therefore, it is expected that the student will acquire some understanding and perspective of the major areas of man's intellectual endeavor. In this sense, philosophical comprehension is an essential part of a student's learning and education.

Philosophy provides a sound preparation for the demands of many professions. For example, the precision of argument and broad acquaintance with intellectual traditions emphasized in philosophy form an excellent basis for the study of law.

Only one course (Philosophy 41, 42, 43S, or 44S) may be taken for credit. These courses are not open to juniors and seniors.

**41. Introduction to Philosophy.** Examination of problems in philosophy; emphasis on metaphysics and theory of knowledge. One course. *Staff*

**42. Introduction to Philosophy.** Examination of problems in philosophy; emphasis on ethics and value theory. One course. *Staff*

**43S. Introduction to Philosophy.** Philosophy 41 conducted as a seminar. One course. *Staff*

**44S. Introduction to Philosophy.** Philosophy 42 conducted as a seminar. One course. *Staff*

**48. Logic.** A study of the conditions of effective thinking and clear communication. Examination of the basic principles of deductive reasoning. One course. *Ross or Sanford*

**93. History of Ancient Philosophy.** The pre-Socratics, Socrates, Plato, Aristotle, and post-Aristotelian systems. Freshman prerequisites: previous philosophy course and consent of the instructor. One course. *Mahoney*

**94. History of Modern Philosophy.** Bacon, Hobbes, Descartes, Spinoza, Leibnitz, Locke, Berkeley, Hume, and Kant. Freshman prerequisites: previous philosophy course and consent of instructor. One course. *Peach*

**101. Philosophy of Religion.** Selected concepts and doctrines. One course. *Roberts*

**102. Aesthetics: The Philosophy of Art.** The concept of beauty, the work of art, the function of art, art and society, the analysis of a work of art, criticism in the arts. One course. *Welsh*

**103. Symbolic Logic.** Detailed analysis of deduction and of deductive systems. Open to sophomores by consent of instructor. One course. *Ross*

**104. Philosophy of Science.** The principal philosophical and methodological problems in contemporary science. One course. *Ross*

**105. Philosophy of History.** History as a form of inquiry; problems of explanation; objectivity and the historical individual; general interpretations of the historical process. One course. *Staff*

**106. Philosophy of Law.** Natural law theory; legal positivism; legal realism; the relation of law and morality. One course. *Golding or Roberts*

**107. Political and Social Philosophy.** Discussion of the fundamental principles of political and social organizations. One course. *Mahoney*

**108. Social Ideals and Utopias.** Reading of selected Utopias; analysis of the value structures and political principles of these ideal societies. One course. *Boudreaux*

**109. Philosophy of Language.** A philosophical analysis of problems arising in the study of language and symbolism. Topics include: theories of language, the na-

ture of signs and symbols, theories of meaning, types of discourse (scientific, mathematical, poetic), definition, ambiguity, metaphor. One course. *Welsh*

**110. Epistemology.** A treatment of the problems of truth and knowledge; of a *priori* and empirical statements; and of theories of perception and probability. One course. *Sanford or Roberts*

**111. Metaphysics.** A selection from the following: theories of substance, universals, identity, space, time, and causality; determinism and action; the relation of mind and body. Prerequisite: one course in philosophy. One course. *Sanford*

**112. Philosophy of Mind.** Such topics as mind and body, thought, perception, persons, and personal identity. One course. *Welsh, Roberts, or Sanford*

**116. Systematic Ethics.** Problems in moral philosophy: the nature of morality, ethical relativism, egoism, utilitarianism. Both historical and contemporary readings, with emphasis on the latter. One course. *Bamford*

**117. Ancient and Modern Ethical Theories.** The development of ethical thought in the West; the interaction between culture and ethical theory, with special reference to the Greek city-state, Roman law, the Renaissance, the Reformation, and the rise of modern science. Readings in the great ethical philosophers. One course. *Welsh*

**118. Philosophical Issues in Medical Ethics.** Ethical issues arising in connection with medical practice and research and medical technology. Definition of health and illness; experimentation and consent; genetic counseling and biological engineering; abortion, contraception, and sterilization; death and dying, codes of professional conduct; and the allocation of scarce medical resources. Prerequisite for freshmen: previous philosophy course and consent of instructor. One course. *Golding, Roberts, or Sanford*

**119. Medieval Philosophy.** Readings and discussion of Christian, Islamic, and Jewish philosophy from late antiquity to 1300. Special emphasis on the nature and destiny of man, human knowledge and conduct, and the question of the existence and nature of God. One course. *Mahoney*

**120. Late Medieval and Renaissance Philosophy.** Critical trends in fourteenth-century philosophy; Renaissance Platonism, humanism and theories of love; Aristotelianism and the immortality controversy; the rebirth of skepticism; and the rise of modern philosophy. One course. *Mahoney*

**132. Nineteenth-Century Philosophy.** Major nineteenth-century philosophers; emphasis on the German tradition: Hegel, Schopenhauer, and Nietzsche. One course. *Bamford*

**134. Existentialism.** One or more major texts, such as Sartre's *Being and Nothingness*. One course. *Roberts*

**191, 192, 193, 194. Independent Study.** Directed reading and research. Open only to highly qualified students in the junior and senior year, with consent of the department. *Staff*

**196S, 197S, 198S, 199S. Seminars in Philosophy.** Prerequisite: one course in philosophy or permission of the instructor. One course each. *Staff*

#### For Seniors and Graduates

**202. Aesthetics: The Philosophy of Art.** A study of some fundamental issues in aesthetics with particular reference to the fields of literature, music, and paint-

ing. Problems discussed include the role of standards in criticism, aesthetic judgment, interpretation, evaluation in the arts, meaning in the arts, art and truth, the arts and morality. Open to juniors with the consent of the instructor. One course. *Welsh*

**203. Contemporary Ethical Theories.** Study of the nature and justification of basic ethical concepts in the light of the chief ethical theories of twentieth-century British and American philosophers. One course. *Roberts*

**204. Philosophy of Law.** Natural law theory and positivism; the idea of obligation (legal, political, social, moral); and the relation of law and morality. One course. *Staff*

**205. Philosophy of History.** The nature of historical knowledge and inquiry; theories of the historical process. One course. *Staff*

**206. Topics in Ethical Theory.** One course. *Staff*

**208. Political Values.** Analysis of the systematic justification of political principles and the political values in the administration of law. One course. *Golding*

**211. Plato.** A critical study of selected dialogues, with emphasis on problems in epistemology and metaphysics. One course. *Mahoney*

**217. Aristotle.** A study of passages from the *Organon*, *Physics*, *De Anima*, and *Metaphysics*. One course. *Mahoney*

**218. Medieval Philosophy.** Selected problems in medieval philosophy. One course. *Mahoney*

**225. British Empiricism.** A critical study of the writings of Locke, Berkeley, or Hume with special emphasis on problems in the theory of knowledge. One course. *Peach*

**227. Continental Rationalism.** A critical study of the writings of Descartes, Spinoza, or Leibniz with special emphasis on problems in the theory of knowledge and metaphysics. One course. *Peach*

**228. Recent and Contemporary Philosophy.** A critical study of some contemporary movements in philosophy with special emphasis on the work of Moore, Russell, Wittgenstein, Wisdom, and Ryle. One course. *Welsh*

**231. Kant's Critique of Pure Reason.** One course. *Staff*

**232. Recent Continental Philosophy.** Selected topics. One course. *Staff*

**233. Methodology of the Empirical Sciences.** Recent philosophical discussion of the concept of a scientific explanation, the nature of laws, theory and observation, probability and induction, and other topics. Prerequisite: consent of the instructor. One course. *Ross*

**234. Problems in the Philosophy of Science.** Selected problems in the physical and nonphysical sciences such as space and time, measurement and determinism. Prerequisite: consent of instructor. One course. *Ross*

**241. Symbolic Logic.** Detailed analysis of deduction and of deductive systems. One course. *Staff*

**251. Epistemology.** Selected topics in the theory of knowledge, e.g., conditions of knowledge, scepticism, and certainty, perception, memory, knowledge of other minds, and knowledge of necessary truths. One course. *Sanford*



**252. Metaphysics.** Selected topics: substance, qualities and universals, identity, space, time, causation, and determinism. One course. *Sanford*

**253. Philosophy of Mind.** Analysis of concepts such as thought and belief; issues such as mind-body relations, thought and action, the nature of persons and personal identity. One course. *Roberts*

**254. Philosophy of Religion.** Topics such as proofs of the existence of God, meaningfulness of religious language, the problems of evil, immortality, and resurrection. One course. *Roberts*

**255. Philosophy of Action.** Problems in the individuation, characterization, and explanation of human actions; an analysis of such concepts as choosing, deciding, intending, doing, making, letting. One course. *Sanford*

**260. Wittgenstein.** An examination of the *Tractatus* or the *Investigations*. One course. *Welsh*

**287, 288. Foundations of Mathematics.** See description for Mathematics 287, 288. (Also listed as Mathematics 287, 288.) One course. *Shoenfield*

**291, 292. Seminar in Special Fields of Philosophy.** One course. *Graduate Staff*

## DEPARTMENTAL MAJOR

*Major Requirements.* Eight semester-courses in philosophy of which at least six must be in courses numbered above 48. The following must be included: Philosophy 93 and 94; one non-introductory course in theory of value. Philosophy 48 is recommended, though not required.

*Related Work.* Two courses minimum in each of two departments approved by the philosophy adviser. Courses may not be those primarily open to freshmen. There is no restriction in principle as to departments in which related work may be taken, and the approval of the philosophy adviser is required only to insure some coherence in the program of major and related work as a whole.

The department offers work leading to graduation with distinction. See the section on Honors.

## Physics

Professor Walker, *Chairman*; Professor Roberson, *Director of Undergraduate Studies*; Professor Bilpuch, *Coordinator of General Physics*; Professors Biedenharn, Fairbank, Gordy, Lewis, Meyer, Newson, Robinson, and Walter; Associate Professors Cusson, De Lucia, Evans, Fortney, and Han; Assistant Professors Friedman, Goshaw, Lawson, Lisowski, Loos, Nelson, and Smith; Instructors Outlaw and Roe; Lecturer Maripuu

Physics courses aim to develop in students a knowledge of the fundamental concepts of physics and the analytical skills necessary for scientific work. The undergraduate program provides students with appropriate academic background for positions in industry, government laboratories, or for graduate study. A program is also available which prepares students for the study of medicine while giving them a strong background in physics.

**32. History of Physics.** Theories including Newtonian Mechanics, atomic structure, quantum theory, relativity, nuclear and particle physics; their developers and technological applications. No previous knowledge of physics assumed. One course. *Walker*

**33. Energy: Principles, Problems, Alternatives.** Basic principles of physics as related to energy, the energy crisis, possible sources and alternatives. Conservation, and environmental aspects of energy consumption. Optional special topics laboratory. No previous knowledge of physics assumed. One course. *Robinson*

**36. Acoustics and Music.** Physical principles underlying musical instruments, room acoustics, and the human ear. Analysis, reproduction, and synthesis of musical sounds. No previous knowledge of physics is assumed. (Also listed as Music 36.) One course. *Lawson*

**41, 42. Fundamentals of Physics.** For students interested in majoring in physics; taken in the freshman year. Basic principles of physics, mainly classical, at a level similar to Physics 51-52, but with emphasis on laying a foundation for further study. Three lecture-recitations and one three-hour laboratory. Prerequisites: approval of the Director of Undergraduate Studies; Mathematics 31-32 or equivalent (may be taken concurrently). Two courses. *Lewis*

**51, 52. General Physics.** Basic principles of general physics treated quantitatively. Designed for students entering medicine, engineering, and the sciences. Not open for credit to students who have completed Physics 41, 42. Students planning to major in physics should enroll in Physics 41, 42 in their freshman year. Prerequisites: Mathematics 31, 32 or equivalent (may be taken concurrently with consent of instructor). Two courses. *Bilpuch, Fairbank, Fortney, Goshaw, Lisowski, Nelson, or Outlaw*

**51P, 52P. Preceptorials.** Elective preceptorials for students enrolled in Physics 51, 52.

**55. Introduction to Astronomy.** Man's evolving theory of the physical universe. Cosmological models, galaxies, stars, interstellar matter, the solar system, and experimental techniques and results. Several observatory sessions per semester. One course. *De Lucia*

**102. Applications of Modern Physics in Medicine.** Recent applications of physical phenomena in medical investigations including lasers, ultrasonics, X-rays, radioactivity, radiation therapy, cryogenics, and electronic techniques. Prerequisites: Physics 41, 42 or 51, 52. One course. *Walter*

**105. Introduction to Astrophysics.** Basic principles of astronomy treated quantitatively. Cosmological models, galaxies, stars, interstellar matter, the solar system, and experimental techniques and results. Prerequisite: Mathematics 31 or consent of the instructor. One course. *De Lucia*

**106. Topics in Astrophysics.** Current topics with emphasis on contributions of the basic sciences. Experimental and observational opportunities. Prerequisite: Physics 55 (or 105) or consent of instructor. One course. *De Lucia*

**161. Modern Physics.** Relativity, quantum phenomena, atomic and molecular structure and spectra, solids, statistical physics, nuclear physics, elementary particles. Prerequisites: Physics 41, 42 or 51, 52 and Mathematics 32. One course. *Roberson*

**171. Electronics.** Elements of electronics including circuits, transfer functions, solid state devices, transistor circuits, operational amplifier applications, digital circuits and computer interfaces. Three lectures and one three-hour laboratory. Prerequisites: Physics 41, 42 or 51, 52. One course. Prerequisites: Physics 41, 42, or 51, 52, *Fortney*

**176S. Thermodynamics and Kinetic Theory.** Thermodynamics, kinetic theory,

and elementary statistical mechanics. Prerequisites: Physics 41, 42 or 51, 52 and differential and integral calculus. One course. *Meyer*

**181. Introductory Mechanics.** Newtonian mechanics at the intermediate level, Lagrangian mechanics, linear oscillations, special relativity. Prerequisites: Physics 41, 42 or 51, 52 and differential and integral calculus. One course. *Han*

**185. Optics and Spectroscopy.** Wave motion, Fourier methods, geometrical and physical optics, coherence, lasers, and atomic and molecular spectra. Prerequisites: Physics 41, 42, or 51, 52, and differential and integral calculus. One course. *Loos*

### For Seniors and Graduates

**211, 212. Advanced Modern Physics.** Quantum theory with applications to the study of atoms, molecules, solids, and nuclei. Prerequisites: Physics 161, 181 or equivalents; Mathematics 285-286 or equivalent (may be taken concurrently). Two courses. *Robinson*

**215. Introduction to Quantum Mechanics.** Wave mechanics and elementary applications; the hydrogen-like atoms; electron spin and angular momentum; operators and eigenvalues; stationary state perturbation theory; identical particles. Prerequisites: courses in modern physics and intermediate mechanics; Mathematics 285-286 may be taken concurrently. One course. *Evans*

**217S, 218S. Advanced Physics Laboratory and Seminar.** Experiments involving the fields of mechanics, electricity, magnetism, heat, optics, and modern physics. Two courses. *Meyer*

**220. Electronics.** Basic elements of modern electronics including a.c. circuits, transfer functions, solid state service, transistor circuits, operational amplifier applications, digital circuits, and computer interfaces. One course. *Fortney*

**223. Electricity and Magnetism.** Electrostatic fields and potentials, boundary value problems, magnetic induction, energy in electromagnetic fields, Maxwell's equations, introduction to electromagnetic radiation. One course. *Loos*

**225, 226. Elementary Investigations.** Training in the laboratory and library methods of physical research. Qualified students may conduct elementary investigations under the supervision of a member of the staff. Two courses. *Staff*

**231. Masers and Lasers.** Theory and applications of quantum electronic devices operating in the spectral range from radiowaves to visible light. Prerequisite: Physics 161. One course. *Gordy*

**240. Computer Application to Physical Measurement.** Discussion and application of various computer interfacing techniques for data acquisition, processing, display, and control in the modern experimental arrangement. Experience with a laboratory computer. Prerequisites: Physics 171 or consent of instructor. One course. *Fortney*

**268. Mathematical Foundations of General Relativity.** (Also listed as Mathematics 268.) One course. *Cantor*

**280. Nuclear Reactor Physics.** Neutron diffusion theory, reactor criticality, kinetics, control, and reactivity effects. Slowing-down of neutrons, age theory, resonance absorption, temperature effects, and multigroup methods. Prerequisites: Physics 161; Mathematics 285-286 or equivalent (may be taken concurrently). One course. *Cusson*

**282. Mechanics of Continuous Media.** Small vibrations, rigid body motion, hydrodynamics, elasticity. Prerequisites: Physics 41-42 or 51-52 and differential and integral calculus. One course. *Walker*

## DEPARTMENTAL MAJOR

Students planning to major in physics should enroll in Physics 41, 42 in their freshman year. They should also arrange to complete the necessary mathematics as soon as possible.

### The A.B. Degree

*Prerequisites.* Physics 41, 42 or 51, 52 or equivalent; Mathematics 31, 32 or equivalent, 103, 104, or 131; two courses in another natural science.

*Major Requirements.* At least six semester-courses in physics from the available 100- and 200-level courses. Of these at least one course must be a laboratory course. A physics major also normally takes two courses of related work beyond the introductory level, in a program approved by the physics adviser.

### The B.S. Degree

*Prerequisites.* Physics 41, 42 or 51, 52 or equivalent; Mathematics 31, 32 or equivalent, 103, 104, or 131; two courses in another natural science.

*Major Requirements.* At least eight semester-courses in physics at the 100- and 200-level. These courses are normally Physics 161, 171, 181, 176, 211, 212, 218, and 223. Students planning graduate study are urged to take two or more electives in physics. B.S. physics majors also take two courses of related work beyond the introductory level, in programs approved by their physics adviser.

The department offers to the student in the senior year the possibility of being associated with research conducted in this department. Such work may lead to graduation with distinction. See the section on Honors.





## Political Science

Professor Barber, *Chairman*; Professor Hall, *Director of Undergraduate Studies*; Professors Braibanti, Cleaveland, Grzybowski, Hallowell, Holsti, Hough, Kornberg, and Leach; Adjunct Professor Choudhury; Associate Professors Eldridge, Fish, Hawley, Johns, Paletz, Price, Rogowski, Salamon, Spragens, and Valenzuela; Assistant Professors Falcone, Kruzel, McKean, Mishler, and Stone; Lecturer O'Barr

Courses in political science for undergraduates are offered in four fields: (1) American government, politics, and public administration; (2) comparative government and politics; (3) political theory and methodology; and (4) international law, relations, and politics. In each field, a basic course (numbered at the 90-level) serves as an introduction both to the study of political science and to the subject matter and approaches of the field, and middle and upper-level courses and seminars (numbered at the 100- and 200-levels respectively) consider particular aspects and topics within the field. In addition, opportunities for independent study under faculty supervision enable students to explore topics of special interest. Students majoring in political science are required to complete at least one course in each of three fields noted above. See page 206 for listing of courses by fields, as well as requirements of the major. See appropriate sub-sections below for information concerning seminars, independent study, internships, and honors.

### INTRODUCTORY COURSES

Each of the following courses provides an introduction to the study of political science and serves as the basic course in one of the four fields of the discipline. Students ordinarily will take at least one of these courses before proceeding to more advanced courses. Some advanced courses may require a particular introductory course as a prerequisite to admission.

**91. The American Political System.** Theory and practice of American government and politics, federal-state relations, the separation and interrelationships of



the executive, legislative, and judicial branches of government, judicial review, the role of political parties and public opinion, the formulation and execution of domestic and foreign policy, civil liberties. One course. *Staff*

**91D. The American Political System.** Same as Political Science 91 except instruction is provided in two lectures and one small discussion meeting each week. One course. *Staff*

**92. Comparative Politics.** Foundations of politics under modern regimes: democratic, authoritarian, totalitarian; the social and political conditions of change, both evolutionary and revolutionary; the bases of political conflict and violence; the role of elite groups, such as the military; mass movements and party systems, theories of development and underdevelopment; and the future of the modern corporate state. Films will be used. One course. *Valenzuela*

**93. Elements of International Relations.** The nature of international politics, the analysis of national power, the instruments of foreign policy, and the controls of state behavior. One course. *Eldridge, Kruzel, or O'Barr*

**94. Contemporary Political Ideologies.** Liberalism, socialism, Marxism and its variants, fascism, contemporary democratic theory. One course. *Hallowell or Spragens*

## OTHER UNDERGRADUATE COURSES

**59S. Television and Politics.** Relationships of the organization, processes, and content of television to politics. Open only to freshmen. One course. *Paletz*

**100. Politics of Liberties and Equality.** Theory and development of the Bill of Rights and the Fourteenth Amendment with attention to Supreme Court decisions and cultural and political forces. One course. *Fish*

**101, 102. Introduction to the Civilizations of Southern Asia.** (Also listed as Interdisciplinary Course 101, 102.) One course. *Staff*

**103. Comparative Fascism and Totalitarianism.** Modern fascism in comparative and historical perspective; particular attention to German National Socialism. One course. *Rogowski*

**105. The Black American in Politics.** Behavior of Black people in the American political system, with special attention to voting organizations and the Black power movement. One course. *Staff*

**107. Comparative Environmental Policies.** Comparative analysis of environmental problems and policies in politically diverse industrialized nations including the United States, Russia, and Japan. (Also listed as Public Policy Studies 107.) One course. *McKean*

**108. The American Presidency.** The presidency and its impact on the American political system. One course. *Paletz*

**109. State and Local Government Today.** Problems in state, county, and city government. One course. *Leach*

**110. The Canadian Polity.** The Canadian political system from a behavioral perspective; relationships of the political culture, individual political behavior, and political institutions; with particular attention to distinctive regional, ethnic, and religious sub-cultures. One course. *Mishler*

**111. Contemporary Japanese Politics.** An introduction to political change in

postwar Japan. Emergence of the modern industrial state and the development of democratic institutions in a non-Western society. One course. *McKean*

**117. Comparative Legal Systems.** Origins, development, and mutual influences of modern legal systems: Roman and civil law; the Common Law and the Anglo-Saxon tradition; Islamic law; communist legal systems and the legal systems of Black Africa. One course. *Grzybowski*

**118. American Constitutional Development.** Prerequisite: Political Science 91 or 91D or consent of instructor. One course. *Fish*

**120. Conflict Resolution: Problems of War and Peace.** The causes and preconditions of human conflict including such factors as deprivation, elite misconceptions, national myths, and civil strife. Consideration of restraints to violent conflict such as negotiation and bargaining. Relevant contemporary international issues such as Vietnam are studied within the context of current social science research. One course. *Eldridge*

**122. Modern International Politics.** An examination of the major problems of post-war international politics with particular attention to the extension of Soviet power, the Western response to this challenge, and the revolutions in the Afro-Asian world. One course. *Eldridge, Kruzell, or O'Barr*

**123. Introduction to Political Philosophy.** The nature and enduring problems of political philosophy, illustrated by selected theorists in the Western political tradition. One course. *Hallowell or Spragens*

**124D. The Political Novel.** Politics and political concepts (totalitarianism, utopianism, fascism, nihilism, obligation and rights,) as portrayed in the novels of Silone, Koestler, Orwell, Dostoevsky, and others. One course. *Staff*

**125. American Political Parties and Practical Politics.** A study of the historical development, organization, and methods of political parties in the United States. One course. *Mishler or Kornberg*

**126. Democratic Theory and Political Reality.** Normative goals and empirical analysis of existing democratic states. One course. *Spragens*

**127. Law and Politics.** Nature and functions of law; Anglo-American legal institutions, the process of judicial decision-making, and the relationships among judges, lawyers, legislators, and administrators in the development of public as well as private law. One course. *Fish*

**128. Congress and the Presidency.** Policy-making in the executive and legislative branches of the U.S. government, with particular attention to intragovernmental relations. One course. *Price*

**129. Groups in American Politics.** Theory and practice of the interest group approach to the study of American politics. One course. *Paletz*

**131. Introduction to American Political Thought.** Basic elements in the American political tradition as developed from its English roots to the present. One course. *Leach*

**135. Comparative Legislative Behavior.** Structures, processes, functions, and behavior of legislatures, and legislative-like institutions in a variety of Western and non-Western societies with emphasis on the role of legislatures in policy formation, national integration, and modernization/development. One course. *Mishler*

**136. Comparative Government and Politics: Western Europe.** Modern political

institutions and processes of Britain, France, Germany, and at least one of the smaller European democracies. Political consequences of divergent patterns of social and economic modernization; regional, religious, and class divisions; the modern role of parliaments; authoritarian, democratic, and pluralist alternatives in contemporary European societies. One course. *Rogowski*

**137. Political Behavior in Elections.** Political participation; public opinion; voting behavior, sociological and psychological bases, comparative studies, models, and methodology of research. One course. *Staff*

**138. Quantitative Analysis of Politics.** Basic applications of statistical tools of analysis of political phenomena. Emphasis on statistical inference. No prerequisites. (Not open to students who have had or are enrolled in Political Science 236, Psychology 117, Mathematics 53 or 183, Management Sciences 110, or Economics 138.) One course. *Holsti*

**139. Bureaucracy and Public Policy.** Analysis of the role of American bureaucracy in the making and execution of public policy. One course. *Hall*

**140. Administrative Law and Government.** Fundamentals of the American system of law and government as reflected in the administrative process. One course. *Hall*

**141. Public Administration.** An introduction to the role of administration in the governmental process considering principles of administrative organization, methods of administrative control, personnel, and fiscal management. In general the study of the organizational and administrative problems encountered by any government agency charged with carrying out public policy. One course. *Cleveland or Hall*

**142. Administrative Responsibility.** An evaluation of political, legal, and administrative methods of achieving a responsible bureaucracy in American national government. Comparisons with relevant experience and techniques in other countries such as Great Britain and France. One course. *Hall*

**144. American Political Thought Since the Gilded Age.** The Progressive Period and the recurring themes of contemporary debate. Attempts to refurbish or develop alternatives to the dominant "liberal tradition." The ideological roots of black, feminist, and "conservative" protest. One course. *Price*

**145S. Political Analysis for Public Policy-making.** (Also listed as Public Policy Studies 114S.) One course. *Hawley, Salamon, or Stone*

**146. American Legislative Behavior.** Structure and operation of the legislative system, with emphasis on background, attitudes and role perceptions, and decision-making behavior of national and state legislators. One course. *Mishler or Paletz*

**147S. Statutory Regulation of Political Activity.** The law of political activity, including such topics as campaign finance reform, lobbying, political influence in administrative decision-making, requirements for voting and candidacy, unethical practices in campaigns and office-holding, and political trials. One course. *Fleishman*

**148. Arab and Non-Arab Muslim World.** Political systems of major Muslim countries, emphasizing the role of Islam in defining the nature of these systems and current international politics of the Middle East. One course. *Braibanti*

**149. United States and East Asia.** Emphasis on conflicts leading to the Pacific



War, the postwar Japanese alliance, and intervention in China, Korea, and Vietnam. One course. *McKean*

**151. Introduction to Latin American Politics.** Historical and cultural context of political institutions and behavior; the role of traditional and emerging groups and forces; political instability and the decision-making process. One course. *Valenzuela*

**152. Authoritarianism and Revolution in Latin America.** Analysis of the politics of major countries including Argentina, Brazil, Chile, Cuba, and Mexico. One course. *Valenzuela*

**153, 154. Politics and the Media of Mass Communication.** Analysis of the nature, organization, and activities of the mass media as they affect the American political system, processes, and members. Governmental impact on the mass media. (Not open to students who have taken Political Science 130.) It is desirable but not required that students taking 153 continue with 154. With consent of the instructor, students who have not taken 153 may enroll in 154. Two courses. *Paletz*

**155. Problems of Political Development in the New States.** Survey of change and modernization in Africa and Asia; nationalism and neutralism, role of political parties, the military, and the bureaucracy in nation-building; economic growth and foreign aid. One course. *Braibanti*

**157. Foreign Policy of the United States.** Sources of American foreign policy, containment, international economic policy, deterrence, arms control and disarmament. Prospects in the post-Vietnam era. Emphasis on the period since World War II. One course. *Holsti*

**158. Foreign Policy Decision-making in the United States.** Individual, group, and organizational aspects. Emphasis on the period since World War II. One course. *Holsti*

**159S. Politics of Professions.** (Also listed as Public Policy Studies 134S.) Half-course. *Stone*

**161. Comparative Government and Politics: Africa.** Nationalism, nation-building, and problems of development in sub-Saharan Africa. One course. *Johns*

**162. Comparative Government and Politics: Communist and Socialist Political Systems.** Communist and socialist movements in Europe, Asia, and the Third World; emphasis on party structure and ideology. One course. *Johns*

**163. Women in Developing Societies.** The diverse roles women played in Third World countries prior to European contact, the subsequent transformation under colonial rule, and the current reassessment by the governments of developing societies. One course. *O'Barr*

**165. Government and Politics of the Soviet Union.** Analysis of the Soviet political system, emphasizing the sources of stability and instability and the responsiveness of its policies. Literature on the non-Soviet world (notably the United States) will be included. One course. *Hough*

**166. Soviet Foreign Relations.** Nature of relations with other states. Determinants and formulation of foreign policy. One course. *Hough*

**168. Political Development in East Asia.** Divergent responses in Japan and China to the Western impact; the process of modernization; and the political instability which contributed to World War II. Emphasis on themes of nationalism and imperialism. One course. *McKean*

- 169. Politics in Revolutionary China.** Political process and ideology in China since 1949. Emphasis on manipulation of the political culture and institutionalized revolution. One course. *McKean*
- 170S. The Legal Process and Social Change.** The role of the legal system in effecting and mediating social change. Consideration of different strategies and the circumstances in which they are effective. One course. *Fleishman*
- 171. Race, Class, and Colonialism in Southern Africa.** Domination and opposition in the countries of southern Africa; political consequences of differing forms of colonialism, white settlement, nationalism, and industrialization. One course. *Johns*
- 172. Political Economy of Global Natural Resources.** Analysis of selected national policies on food, energy, and minerals in an interdependent world economy; emphasis on the Third World. One course. *Johns*
- 175. Political Parties and Legislatures in Western Democracies.** The origin, maintenance, and functions of party and legislative systems in Western democratic societies. One course. *Kornberg*
- 176. Urban Politics.** Urban political processes and their impact upon urban policy. One course. *Salamon*
- 180. Comparative Government and Politics: Southern Asia I.** Concepts of political development in new states, using India, Pakistan, Sri Lanka, and Malaysia as case studies. Theory and practice of foreign aid and technical assistance as agents of political modernization. One course. *Braibanti*
- 181. Comparative Government and Politics: Southern Asia II.** The political modernization of India and Pakistan since 1947. Constitutional developments as revealed in leading court judgments will be studied. Other topics will be the ideology of administrative reform, formulation of state policy, rural development, and party politics. One course. *Braibanti*
- 184. Canada: Problems and Issues of an Advanced Industrial Society.** (Also listed as Interdisciplinary Course 184.) One course. *Preston and Visiting Lecturers*
- 186. Political Leadership.** The development, characteristics, and impact of political leaders. Biographical and collective studies are considered primarily from a psychological perspective. One course. *Barber*
- 188. The Psychology of Political Symbols.** The role of symbolic political issues in determining public attitudes and voting behavior. Symbolic political issues such as "law and order," pornography, and prohibition, distinguished from public welfare issues such as employment policies. One course. *McConahay*
- 189, 190. Internship.** Open to enrollment by students engaging in practical or governmental work experience during the summer or a regular semester. To enroll, a student must obtain the approval of the Director of Undergraduate Studies, arrange employment, and secure the agreement of a faculty member in the department to supervise a program of study related to the work experience. Two courses.
- 191, 192. Independent Study.** Directed reading and research. Open only to qualified juniors by consent of the Director of Undergraduate Studies and of the individual instructor. Two courses. *Staff*
- 193, 194. Independent Study.** Directed reading and research. Open only to seniors by consent of the Director of Undergraduate Studies and of the individual instructor. Two courses. *Staff*

**195. Comparative Political Behavior in the United States and Canada.** Similarities and differences in political environments and their impact on political institutions and processes. One course. *Kornberg*

**197S. Principles and Methods of Political Inquiry.** Philosophical, scientific, and behavioristic approaches to political problems; contemporary conceptual frameworks, including systems analysis and functionalism, group theory, and mathematical models. Prerequisite: consent of instructor. One course. *Staff*

**198. Senior Honors Seminar.** Open only to senior political science majors who are candidates for the degree with distinction. Preparation and writing of a research paper; group meetings to discuss common problems. Prerequisite: Political Science 197 or consent of the instructor. *Staff*

**200S. Senior Seminars.** One course each. *Staff*

A. American Government and Politics

B. Comparative Government and Politics

C. Political Theory

D. International Relations

### For Seniors and Graduates

**201. Arms Control and Defense Strategy.** Influences on national and international security. Prerequisite: one course in international relations or American foreign policy. One course. *Kruzel*

**204. Ethics in Political Life.** Ethical issues arising in the conduct of political vocations and activities. (Also listed as Public Policy Sciences 204.) One course. *Spragens*

**206. Politics and the Media.** The relationship between the media of mass communication and the American political process. Open to upperclassmen with consent of instructor. One course. *Paletz*

**207. American Constitutional Interpretation.** Development of the constitution of the United States through Supreme Court decisions. Prerequisite: Political Science 127. One course. *Fish*

**209. Problems in State Government and Politics.** One course. *Leach*

**210. The Politics of Education.** The forces in local, state, and national politics which impinge on educational policymaking and administration. Not open to students who have had Political Science 313. (Also listed as Education 210.) One course. *Leach*

**211S. Problems and Issues in Japanese Politics.** The nature of political opposition, citizenship, and the civic culture, decision-making in a "vertical" society, problems as a post-industrial state. One course. *McKean*

**212. Japanese Foreign Policy.** The transition from militarism to pacifism in Japan's international posture, emphasis on the postwar American alliance, the questions of rearmament and nuclear weapons, and the domestic constraints on foreign policy-making. One course. *McKean*

**215. Comparative Legislative Processes.** Analysis of the structures and functions of legislative institutions and of the behavior of legislative elites in both parliamentary and congressional systems. One course. *Mishler*

**216S. Comparative Politics of the Welfare State.** Analysis of the political proc-

esses that shape very different solutions of similar social problems in advanced industrial nations. Examination of the development of income-maintenance programs and health care systems, with some discussion of other social policies. (Also listed as Public Policy Sciences 216S.) One course. *Stone*

**217S. Economic Theories of Political Behavior.** Analysis of economic theories and other formal techniques applied to problems of voting behavior, legitimacy, and constitutional choice, and to strategies of political conflict and coalition. One course. *Rogowski*

**218S-219S. Political Thought in the United States.** Writings of leading political theorists. First semester: founding fathers and their European and Puritan antecedents; the abolitionists and Calhoun. Second semester: Progressive period and recurrent themes of contemporary protest and debate. (Offered in alternate years.) Two courses. *Price*

**220S. Problems in International Politics.** Prerequisite: one course on international relations, foreign policy, or diplomatic history. One course. *Holsti*

**221. International Organization.** The functioning of the United Nations system and of regional organizations operating in the political and security fields. One course. *Staff*

**222. Empirical Theory.** Critical examination of contemporary, non-normative conceptual frameworks for political inquiry, with emphasis on the qualifications of these frameworks as theories. One course. *Staff*

**223. Political Philosophy from Plato to Machiavelli.** Intensive analysis of the political philosophies of Plato and Aristotle, a survey of medieval political thought and an analysis of the significance of Machiavelli. One course. *Hallowell*

**224. Modern Political Theory.** An historical survey and philosophical analysis of political theory from the beginning of the seventeenth to the middle of the nineteenth century. Attention is given to the rise of liberalism, the Age of Enlightenment, the romantic and conservative reaction, idealism, and utilitarianism. One course. *Hallowell*

**225. Comparative Government and Politics: Western Europe.** Rise of modern political parties; extension of the suffrage; entry of bourgeoisie, peasants, and workers into politics; center-periphery conflicts; emergence of the welfare state and of planned economies; problems of "collectivist" politics. One course. *Rogowski*

**226. Theories of International Relations.** Contemporary theories of international relations and foreign policy. Emphasis on the interdependence of theory and empirical research. One course. *Eldridge*

**227. International Law.** Elements of international law, particularly as interpreted and applied by the United States; rights and duties of states with respect to recognition, state territory and jurisdiction, nationality, diplomatic and consular relations, treaties, treatment of aliens, pacific settlement of disputes, international regulation of the use of force, and collective responsibility. One course. *Grzybowski*

**229. Recent and Contemporary Political Theory.** The rise of positivism and its impact upon modern political thought, the origins of socialism, Marxism and its variants, socialism in the Soviet Union, nationalism, fascism and national socialism, the crisis in modern democracy, Christianity and social order. (Not open to students who have taken Political Science 132.) One course. *Hallowell*



**230. American National Government.** Formation and contemporary operation of the national political system; historical and behavioral approaches. One course. *Staff*

**231. American Political Theory.** An analysis of the main currents in American political thought from colonial beginnings to the present day, with emphasis upon the development of liberalism in America. One course. *Leach*

**233. Research Methodology.** Measurement, causal analysis, and comparison of different levels of analysis, and other problems in political research. One course. *Staff*

**234S. Political Economy of Development: Theories of Change in the Third World.** Alternative approaches to political, economic, and social change in Latin America, Africa, and Asia. (Also listed as History 234S.) One course. *Bergquist and Valenzuela*

**235. The Commonwealth.** Analysis of political relationships among the members of the Commonwealth countries, with emphasis on Canada. One course. *Staff*

**236. Statistical Analysis.** Introduction to statistics in political research, emphasizing inferential statistics through simple regression and correlation. Not open to students who have had or are enrolled in Political Science 138, Psychology 117, Mathematics 53 or 183, Management Sciences 110, or Economics 138. One course. *Holsti*

**237S. Problems in American Foreign Policy.** The decision-making process as applied to contemporary foreign policy issues. Prerequisite: Political Science 122 or the equivalent. One course. *Staff*

**238. Comparative Foreign Policy.** An application of comparative theory to the foreign policy decision-making processes of major, middle range, and developing states. One course. *Eldridge*

**239S. Current Problems of International Law.** Theoretical trends, use of sources for research, role of international law in diplomacy and legal practice. For seniors and graduates only. One course. *Grzybowski*

**241. Public Administrative Organization and Management.** The American administrative process: theory and practice of administrative organization and management. One course. *Hall*

**243. Applications of Administrative and Organizational Theory.** Behavioral analysis of public organizations with emphasis on the impact of organizational structures, individual needs and motivation, and politics on the formulation and implementation of public policy. (Also listed as Public Policy Sciences 224.) One course. *Hawley*

**244. Administrative Law and Process.** The nature and law of the administrative process in the context of American government and politics, with special attention to the powers, procedures, and judicial control of administrative agencies. One course. *Hall*

**245S. Ethics and Policy-making.** (Also listed as Public Policy Sciences 223S.) One course. *Price*

**246. Administration and Public Policy.** The role of administration in the American policy process. One course. *Hall*

**247. Political Participation and Policy Outcomes.** Impact of citizen participa-

tion upon governmental decision-making. Theoretical issues and empirical evidence (primarily American, but partly comparative). (Also listed as Public Policy Sciences 247.) One course. *Hough*

**248. The Politics of the Policy Process.** (Also listed as Public Policy Sciences 219.) One course. *Salamon and Stone*

**249. Comparative Political Analysis and Political Development.** General methodology of comparison of political systems. Institutional, structural, functional, and configurative modes of analysis. Theory of political development. Theoretical problems of induced political change. One course. *Braibanti*

**250. Comparative Government and Politics: Southern Asia.** The political development of India and Pakistan. Contextual determinants of the political systems. Political consequences of partition. National integration, constitutional, and institutional aspects of the political systems. Impact of foreign technical assistance. One course. *Braibanti*

**252. Comparative Political Behavior and Socialization.** Elites and mass publics in a variety of Western and non-Western societies including the United States; models of the political socialization process and their implications for democratic theory. One course. *Mishler*

**253. Comparative Government and the Study of Latin America.** Current literature on major themes of Latin American politics. One course. *Valenzuela*

**257S, 258S. Modern East Asia. Introduction to Problems and Literature.** (Also listed as Interdisciplinary Course 257S, 258S.) Two courses. *McKean*

**260. The Tradition of Political Inquiry.** Past and present problems, goals, pre-suppositions, and methods. One course. *Spragens*

**273S. The American South as a "Developing Society."** The concept of modernization as a tool of social and political analysis, and its applicability in explaining the patterns of political and economic evolution in the American South. One course. *Salamon*

**274. Political Psychology.** Psychological theories on political attitudes and opinions ranging from those of Fechner, von Helmholtz, Thurstone, and Likert to the more recent work of Festinger, Bem, McGuire, Converse, Lane, and the functionalists. One course. *McConahay*

**275. The American Party System.** An intensive examination of selected facets of American national political parties, such as relationships between presidential and congressional politics, the politics of national conventions, recent foreign policy and party alignments, and the controversy over party government. One course. *Kornberg*

**277. Comparative Party Politics.** The impact of social and political systems on party structures, functions, ideologies, and leadership recruitment. Emphasis upon research techniques and objectives. One course. *Kornberg*

**278. Canadian Political Behavior in the North American Context.** Institutional processes and political behavior in Canadian and American societies. Impact of multi-partyism, federalism, political and cultural particularism, and the elite structure. One course. *Kornberg*

**279. The Legislative Process.** An analysis of the structure and functions of Congress with emphasis on the behavior of legislators and resultant public policy.

Some considerations will be given to American state and foreign legislatures. One course. *Paletz*

**280. Comparative Government and Politics: Sub-Saharan Africa.** Politics and government in selected African states, with particular attention to the problems of decolonization and modernization in the post-independence period. One course. *Johns*

**283S. Congressional Policy-making.** Lawmaking and oversight of the bureaucracy by the United States Congress. Committee roles, impact of the executive and other external forces. (Also listed as Public Policy Science 283S.) One course. *Price*

**285. The Judicial Process.** A study of judicial decision-making in the United States, with emphasis on the process of litigation, the recruitment of judges, the influences and limits on judicial decisions, and their impact within the political system. Prerequisite: Political Science 127 or 207 or the equivalent. One course. *Fish*

**291. Problems of Urban Government.** One course. *Leach*

**293. Federalism.** Theoretical and operational aspects of federal systems of government, focusing on the United States and Canada. One course. *Leach*

## SEMINARS FOR UNDERGRADUATES

Each semester certain courses at both the 100- and 200-level are offered as seminars and are so designated in the Official Course Schedule by an S following the course number, e.g., 135S, 217S. In addition, senior seminars (200A, B, C, D) in each of the four fields of the discipline are offered each year, with preference in admission being given to senior political science majors.

## INDEPENDENT STUDY

Independent study, (191, 192, 193, 194), normally consisting of intensive reading and research and the preparation of a substantial written report or paper, permits the student to explore topics of special interest not covered by regular courses or seminars. Ordinarily undertaken in the junior and senior years following, or concurrent with, some course work in political science, independent study presupposes not only a special interest on the student's part in a particular topic, but also an ability and willingness to work rigorously and independently in the furtherance of that interest. Interested students may see the Director of Undergraduate Studies for further information.

## POLITICAL INTERNSHIPS

The Department organizes an internship program each summer, primarily in Washington, D.C., for political science majors and interested non-majors. Students participate by qualifying for a position obtained by the department or by acquiring their own relevant employment. Interns may or may not receive payment for their services; some qualify for financial aid through the University. Weekly sessions with guest speakers in Washington are arranged to supplement the interns' work experiences. Course credit can be obtained by enrolling in Political Science 189 or 190, either during the summer or a regular semester, and writing an analytical paper. Application forms are available in the department office (214 Perkins). Potential applicants should contact the Internship Director, Professor David Paletz, at any time but preferably early in the fall semester.

## HONORS IN POLITICAL SCIENCE

A special opportunity for qualified political science majors is the department's honors program, successful completion of which enables the participant to achieve graduation with distinction in political science. The central feature and requirement of the program is the honors thesis which the student prepares under faculty supervision. Participation in the program is open to political science majors who, by the spring semester of the junior year, show promise of achieving at least a *B* average in political science by the time of graduation and give evidence of interest in, and capacity for, the skillful research and writing required for the preparation of a thesis of high (at least A-) quality. Students taking part in this program ordinarily begin by enrolling in Political Science 197S in the spring semester of the junior year, although in exceptional cases alternative approaches are possible. In the fall semester of the senior year, while enrolled in Political Science 198, participating students undertake the research and writing required for the thesis which is then evaluated by a faculty committee early in the spring semester. For further information, see the director of the program or the Director of Undergraduate Studies.

## POLITICAL SCIENCE COURSES BY FIELDS

Political science courses for undergraduates are offered in four fields, as noted below; students majoring in the department must complete at least one course in each of three fields.

*American Government, Politics, and Public Administration.* Political Science 91, 91D, 59S, 100, 105, 108, 109, 118, 125, 127, 128, 129, 137, 139, 140, 141, 142, 145, 146, 147S, 153, 154, 159S, 170S, 176, 186, 188, 189, 190, 191\*, 192\*, 193\*, 194\*, 198\*, 200S A, 206, 207, 209, 210, 230, 241, 243, 244, 246, 247, 248, 273S, 274, 275, 279, 283S, 285, 291.

*Comparative Government and Politics.* Political Science 92, 101, 102, 103, 107, 110, 111, 117, 135, 136, 148, 151, 152, 155, 161, 162, 163, 165, 168, 169, 171, 172, 175, 180, 181, 184, 191\*, 192\*, 193\*, 194\*, 195, 198\*, 200S B, 211S, 215, 216S, 217, 225, 234S, 235, 250, 252, 253, 257S, 258S, 277, 278, 280, 293.

*Political Theory and Methodology.* Political Science 94, 123, 124D, 126, 131, 138, 144, 191\*, 192\*, 193\*, 194\*, 197S, 198\*, 200S C, 204, 218S, 222, 223, 224, 229, 231, 233, 236, 245S, 249, 260.

*International Law, Relations and Politics.* Political Science 93, 120, 122, 149, 157, 158, 166, 191\*, 192\*, 193\*, 194\*, 198\*, 200S D, 201, 212, 220S, 221, 226, 227, 238, 239S, 287S.

## DEPARTMENTAL MAJOR

*Requirements.* Eight courses in political science including (1) at least one course in each of three fields; (2) at least two courses at the 200-level; and (3) no more than three cross-listed courses originated outside the Department of Political Science. (Such cross-listed courses appear in the preceeding listing without descriptions.)

*Suggested Work in Related Disciplines.* Several courses in such disciplines as anthropology, economics, history, philosophy, psychology, public policy, religion, and sociology are desirable.

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\*If subject matter is appropriate to the field.



# Psychology

Professor Bevan, *Chairman*; Professor Wing, *Director of Undergraduate Studies*; Professors Alexander, Borstelmann, Carson, Diamond, C. Erickson, R. Erickson, Guttman, Martin Lakin, Lockhead, H. Schiffman, Staddon, and M. Wallach; Adjunct Professor Campbell; Associate Professors Coie, Costanzo, Hall, and McConahay; Assistant Professors Casseday, Eckerman, Fischer, Kalat, Kremen, Levy, Norton, Robinson, and Roth; Lecturers Boudewyns, Clifford, E. Crovitz, H. Crovitz, Davis, Gasswint, Gehman, Gentry, Marsh, Nebes, Oppenheim, Peele, S. Schiffman, Shows, Somjen, L. Wallach, and Wolbarsht; Adjunct Instructor Musia Lakin; Research Associate Cooper; Visiting Scholar Moulton

**70S, 71S. Freshman Seminars.** Intensive experience through the study of one or two problems of special interest: does not fulfill departmental prerequisites. Prerequisite: consent of the Director of Undergraduate Studies. Half-course or one course each. *Staff*

The following four first-level courses are open to freshmen, sophomores, juniors, and seniors without prerequisite. Some of these courses will have discussion sections or preceptorials, with the availability of these experiences to be specified prior to registration. Students in each of these courses are expected to participate as subjects in three to six hours of psychological research. Individual students need fulfill this requirement only once, even though they take more than one course at this level.

**102. Sensation, Perception, and Learning.** Sensation, including psycho-physics and receptor processes. The concept of reflex, both physiological (Sherrington) and behavioral (Pavlov). Complex organization: learning, perception, and cognition. One course. *Bevan, Guttman, Lockhead, Schiffman, or Staddon*

**103. Biological Basis of Behavior.** Behavior as a product of evolution and the role of behavior in species survival. Neural and endocrine factors in reproduction, hunger, thirst, emotion, and intelligence. Heredity-environment in the development of behavior. One course. *Diamond, C. Erickson, Kalat, or Norton*

**104. Personality.** Representative theories of personality, from Freud to the present, emphasizing problems of normal personality structure, dynamics, development, and assessment. One course. *Alexander, Carson, or Kremen*

**105. Developmental Psychology.** Theory and research on growth and behavior from infancy to adolescence. One course. *Borstelmann, Coie, Costanzo, or Eckerman*

**Intermediate and Advanced Lecture Courses.** Some of these offerings will include discussion sections or preceptorials, as specified prior to registration.

**110. Applied Psychology.** Applications of psychology to problems of personnel selection, industrial efficiency, advertising, and selling. Prerequisite: one course in psychology. One course. *Staff*

**111. Social Psychology.** Problems, concepts, and methods in the study of social interaction and interpersonal influence. Prerequisite: Psychology 102, 103, 104, 105 or consent of the instructor. One course. *Levy*

**117. Statistical Methods in Psychology.** Elementary statistical techniques and their application to the analysis and interpretation of psychological data. Theory of inference is stressed. Psychology majors only. (Not open to students who have had Economics 138, Mathematics 53 or 183, or Management Sciences 110.) One course. *Staff*

**1225. Seminar in Child Observation.** Children are observed in the group setting of the University Preschool and Primary Program. Aspects of personality, social development, and child-adult relationships. Open only to junior and senior psychology majors with consent of instructor. One course. *Musia Lakin*

**127. Learning and Adaptive Behavior.** The principles of instrumental learning in animals and man. Prerequisite: Psychology 102 or 103. One course. *Staddon*

**128. Systems of Psychology.** The main systems in psychology from the mid-nineteenth to mid-twentieth centuries; the introspectionist, functionalist, behaviorist, psychoanalytic, Gestalt, and structuralist positions; the work of Titchener, James, Dewey, Watson, Hull, Freud, Wertheimer, Kohler, and Piaget. Prerequisites: Psychology 102 or 103 and 104 or 105. One course. *Bevan, Guttman, or Kremen*

**129. Survey of the History of Psychology.** Landmarks in systematic psychology from early Greek science to the present. Prerequisites: Psychology 102 or 103 and 104 or 105. One course. *Bevan, Guttman, or Kremen*

**131. Visual Perception.** Structure and function of visual systems, perception of form and brightness, color vision, depth perception, adaptation, and perceptual development. Prerequisite: Psychology 102, 103 or consent of the instructor. One course. *Staff*

**132. The Psychology of Individual Differences.** Nature and causes of individual and group variations in intelligence, special abilities, social and emotional characteristics. Prerequisite: Psychology 102 or 103 and Psychology 117. One course. *Wing*

**133. Biological Aspects of Learning.** Evolution of learning abilities; specialized learning abilities; physiological mechanisms of learning. Prerequisite: Psychology 102 or 103. One course. *Kalat*

**134. Psychology of Language.** An integrative, theoretical approach to psycholinguistics stressing the relation of language and speech to other areas in psychology. One course. *Robinson*

**135. Hormones and Behavior.** The endocrine system and hormones in maternal, sexual, and emotional behavior. Prerequisite: Psychology 103. One course. *C. Erickson*

**136. Advanced Developmental Psychology.** Issues, concepts, and methods in psychological development, e.g., comparative social development, social cognition, adolescence. Prerequisite: Psychology 105 or consent of instructor. One course. *Borstelmann, Coie, Costanzo, or Eckerman*

**137. Physiological Basis of Perception.** Basic concepts and current theories on the neural mechanisms involved in the processing of sensory information. Prerequisite: Psychology 102 or 103. One course. *Norton*

**138. Abnormal Psychology.** Disordered behavior and constructive personality change are viewed in interpersonal and social context for purposes of understanding normal and abnormal personality development and functioning. Prerequisite: Psychology 104 or 105. One course. *Carson, Lakin, or Schiffman*

**139. Motivation.** Contemporary use of such concepts as instinct, drive, and expectancy in the explanation of behavior; the role of nervous mechanisms and hormones in the control of goal-directed behavior. Prerequisite: Psychology 102 or 103. One course. *Guttman*

**Laboratory Courses (140 through 149).** These courses are open chiefly to juniors and seniors. The subject matter varies, but these courses have in common a concern with the design and execution of psychological experiments. Students will find them helpful as a means of gaining experience before engaging in independent study.

**140S. Research Methods in Child Psychology.** Prerequisite: Psychology 105. One course. *Coie, Eckerman, or L. Wallach*

**141S. Tests and Measurements.** Test methods used by psychologists to measure and evaluate mental processes. Prerequisite: Psychology 117 or the equivalent. One course. *Schiffman or Wing*

**142S. Instrumental Behavior.** Laboratory course using animal subjects in operant-conditioning situations. Prerequisite: Psychology 102. One course. *Guttman or Staddon*

**143S. Experimental Methods in Cognitive Psychology.** Human cognition; language, memory, problem-solving, and other higher mental processes. One course. *Staff*

**144S. Learning and Adaptive Behavior.** Basic principles of adaptive behavior in animals, with special emphasis on the effects of reinforcement. Participation in experiments with animals. Prerequisite: Psychology 102, 103, or consent of the instructor. One course. *Staddon*

**145S. Experimental Approaches to Personality.** Methods applied to personality research. Prerequisite: Psychology 104. One course. *Costanzo, Schiffman, or Wallach*

**146S. Experimental Comparative Psychology.** Animal behavior from evolutionary and physiological viewpoints. Emphasis on methodology. Prerequisite: Psychology 102 or 103. One course. *C. Erickson or Kalat*

**147S. Experimental Social Psychology.** Group dynamics, attitude change, and interpersonal perception. Prerequisite: Psychology 111. One course. *Levy*

**148S. Psychology of Perception and Thinking.** Basic phenomena of perception and thinking as determined by conditions in the external situation and in the person—biological and psychological. Prerequisite: Psychology 102. One course. *H. Crovitz or Lockhead*

**149S. Physiological Psychology Laboratory.** Neural bases of behavior, sensory and motor functions of the nervous system, and problems of emotion, motivation, and consciousness. Laboratory in psychophysics and the electrical activity of the nervous system. Prerequisite: consent of the instructor. One course. *R. Erickson*

**152S. Psychological Approaches to Contemporary Problems.** Relevance of various psychological theories and findings to selected contemporary issues. Prerequisite: consent of the instructor. One course. *Staff*

**154S. Education, Children, and Poverty.** Psychological hypotheses concerning the roles of preschool intervention programs, improved quality of resources, teacher expectancy effects, and enhancement of pupil self-confidence, in relation to the goal of improved cognitive competence for poverty background children. Criteria for defining competence, such as scores on psychometric intelligence tests, performing on Piagetian tasks, and development of specific skills. Interpretations concerning intelligence and cognitive deprivation in poor children in the light of

relevant psychological evidence. Prerequisite: one course in psychology or consent of instructor. One course. *M. Wallach*

**165S. Personality Theory.** Theories of personality from larger metatheoretical perspectives. Open to junior and senior majors in psychology or by consent of the instructor. Prerequisite: Psychology 104. One course. *Alexander or Kremen*

**170S. A-D. Seminar in Selected Problems.** One course each. *Staff*

**Tutorial Study.** For juniors and seniors. Small group discussions about influential books and articles in psychology. The availability of tutorials, their content, and their instructors will be announced before registration.

**171T, 172T. Junior Tutorial.** Prerequisites: Psychology 102 or 103; Psychology 104 or 105, and consent of the Director of Undergraduate Studies. Half-course or one course each semester. *Staff*

**173T, 174T. Senior Tutorial.** Prerequisites: Psychology 102 or 103; Psychology 104 or 105; Psychology 117 or the equivalent; and consent of the Director of Undergraduate Studies. Half-course or one course each semester. *Staff*

**177, 178. Independent Study and Research.** Prerequisites: formulation of a study plan with a faculty supervisor and approval of the Director of Undergraduate Studies; Psychology 102 or 103, 104 or 105, and one psychology course numbered 140 through 149; Psychology 117 recommended. One or two courses each semester. *Staff*

**191, 192. Junior Honors Research.** Directed reading research. Open only to qualified juniors who expect to graduate with distinction in psychology. Prerequisite: consent of the director of honors program. One or two courses each semester. *Staff*

**193, 194. Senior Honors Research.** Directed reading and research for seniors planning to graduate with distinction in psychology. Prerequisite: consent of the director of the honors program. One or two courses each semester. *Staff*

Courses at the 200-level are open to selected undergraduates only with written consent of the instructor.

## For Seniors and Graduates

**203. Sensation and Perception.** An examination of the classical concepts in sensation and perception and of the resulting psychophysical data for each of the major senses with emphasis on vision and audition. Modern perceptual formulations are discussed through analysis of the empirical evidence in support of each view. One course. *Lockhead*

**206. Comparative Psychology.** Eminent comparative psychologists and their work. One course. *Kalat*

**210. Cognitive Psychology.** Theoretical approach; stresses interconnections across perception, memory, thinking, language, and use of models. One course. *Robinson*

**212. Human Memory.** Literature, classical and modern; data and theories relating to mechanisms of information processing, storage, and retrieval. One course. *Bevan*

**213. Adaptive Behavior.** The principles of adaptive behavior in animals, with special emphasis on the effects of reward and punishment. Prerequisite: consent of instructor. One course. *Staddon*



**214, 215. Developmental Psychology.** Current research and theory. First semester: comparative and biological approaches to human development. Infancy and social development. Second semester: cognitive development. Two courses. *Eckerman, L. Wallach, and Staff*

**216. Biological Psychology.** The methods of biology (as applied to psychology), especially in neurophysiology, neuroanatomy, and genetics. Topics covered include: the genetics of behavior, the organization of the dorsal thalamus and neocortex, and the limbic system and hypothalamus. Methods covered include: ablation method, method of evoked potential, electrical stimulation of the brain, and classical and physiological genetics. One course. *Diamond*

**217. Social Psychology.** Social factors in cognition, models of social interaction, conformity and social influence, and attitude development and change. One course. *Levy*

**218. Research Methods in Social Psychology.** Emphasis on the interplay between experimental design and technique. One course. *Levy*

**219. Neural Bases of Behavior.** Structure and function of the nervous system as related to problems of sensory-motor processes, learning, and memory. One course. *R. Erickson*

**228. Visually Guided Behavior.** Anatomical and physiological maturation of the nervous structures mediating visual behaviors. How the maturation of the visual pathway may contribute to the development of these behaviors. One course. *Norton*

**230. Social Behavior of Animals.** Developmental, ecological, and physiological aspects of territorial, sexual, parental, and aggressive behavior. One course. *C. Erickson*

**234. Seminar in Personality.** Selected topics of current interest concerning empirical research on personality. Strategies for the definition of research questions and the evaluation of research progress. One course. *M. Wallach*

**238. Electroencephalogram and Psychological Function.** A survey of experimental and clinical literature on brain wave correlates of intelligence, personality, behavior disorders, epilepsy, sleep, sensory stimulation, reaction time, and attention. Emphasis on the electrophysiology of conditioning and learning. Lectures, laboratory demonstrations, and clinical case presentations. One course. *Marsh*

**245. Personality Theory.** Representative theories of human functioning, from Freud to contemporary approaches. One course. *Staff*

**253. Psychological Approaches to Public Policy Analysis.** (Also listed as Public Policy Sciences 253.) One course. *McConahay*

**261. Science, Politics, and Government.** The structure and values of the scientific community, the mechanism and strategies of government, and their mutual interdependence in American society. (Also listed as Public Policy Sciences 255 and Sociology 261.) One course. *Bevan or McKinney*

**271S. Selected Problems.** One course. *Staff*

**273-274. Statistical Principles in Experimental Design.** The problems of scientific inference; methods of data analysis and issues in experimental design. Two courses. *Roth*

**276. Neuroanatomical Basis of Sensory Physiology.** Original papers are read

and discussed which are concerned with the neuroanatomical substrates underlying sensory processing in the auditory and visual systems. (Also listed as Anatomy 276.) One course. *Hall*

**280. Psychology as a Science.** Epistemology of psychology in its historical evolution from Mach, Newton, and Kant through Darwin, Freud, and Hull; emphasis on practice in current areas of science; roles of research techniques and language, construct usage, hypotheses, and general processes of developing understanding in various current areas. One course. *R. Erickson*

**283, 284. The History of Psychology.** First semester: Aristotle to Kant; second semester: development of modern psychology. Prerequisite for Psychology 284: Psychology 283 or consent of instructor. Two courses. *Guttman*

**293. Methods in Developmental Psychology.** Methodological and epistemological issues in research in development. Individual and group research projects are an integral part of the course. One course. *Staff*

## DEPARTMENTAL MAJOR

*Major Requirements.* Eight courses in psychology, including 102 or 103 and 104 or 105, Psychology 117, plus five additional psychology courses of the student's selection. Mathematics 53, 183, Economics 138, or Management Science 110 may be substituted for Psychology 117 but do not count as one of the eight required courses.

Students seeking a B.S. degree must complete, in addition to the above requirements, a minimum of two calculus courses and six additional courses in the natural sciences or mathematics.

## Public Policy Studies

Professor Fleishman, *Director*; Associate Professor Hawley, *Associate Director*; Assistant Professor Decker, *Director of Undergraduate Studies*; Professors Estes (Medicine), Hough (Political Science), and Lange (Law); Associate Professors Behn, Blaydon, Ginsburg, Goodwyn, Grabowski, McConahay, and Price; Assistant Professors Cook, Fischer, Kuniholm, Lipscomb, Nagin, Salamon, Stack, and Stone; Lecturers Payne and Vaupel

The policy studies major is an interdisciplinary social science program designed to provide students with the skills, analytical perspectives, and descriptive information which policy analysts need to deal effectively with major contemporary social problems. The course of study familiarizes the student with the kind of contribution each of several disciplines (political science, economics, social psychology, applied mathematics, and the humanities) can make to policy analysis. Opportunities are provided, both in the classroom and through field experiences, for students to integrate this material and apply it to analyzing specific public policy issues.

Students majoring in public policy are able to participate in a variety of learning experiences including seminars, lecture discussion classes, individual study, policy workshops, and an internship. In addition, students are urged to participate actively in numerous programs sponsored by the Institute which supplement material covered in class. As a matter of policy, students are asked to evaluate teaching and course content and are provided both formal and informal opportunities to shape the Institute's program and curriculum.

Courses in public policy are open to all students providing that the prerequisites (if any) cited for individual courses are met.

**55. Analytical Methods for Public Policy-making.** Basic concepts of analytical thinking including quantitative methods for assessing the probabilities of outcomes and appraising policy alternatives. Illustrated by problems faced by busy decision-makers in government, business, law, medicine, etc. One course. *Behn, Fischer, or Vaupel*

**107. Comparative Environmental Policies.** (Also listed as Political Science 107.) One course. *McKean*

**110. Economic Analysis for Public Policy-making: Microeconomic and Non-Probabilistic Models.** Application of microeconomic analysis to public policy areas, including agriculture, housing, taxation, and income redistribution. Prerequisite: Economics 52 or equivalent. One course. *Cook or Lipscomb*

**112. Policy Evaluation and Experimentation.** Uses and limitations of statistical methods, including experimentation, for monitoring and evaluating public policies. Prerequisite: Public Policy Studies 55. One course. *Staff*

**114. Political Analysis for Public Policy-making.** Analysis of the political and organizational processes which influence the formulation and implementation of public policy. Alternative models. (Also listed as Political Science 145S.) One course. *Hawley, Salamon, or Stone*

**116. Policy Choice as Value Conflict.** Theoretical and practical problems in decision-making in relation to conflicts of value and of interest. How norms deriving from professional ethics, ideology, law, and other sources are manifest in such policy issues as welfare, environmental management, and national defense. One course. *Payne or Decker*

**131S. The Politics of Educational Reform.** Contemporary demands for the reform of public schools in light of the history of reform efforts and various theories of social action and organizational change. First half of semester. Half-course. *Hawley*

**132S. Multinational Enterprises and Public Policy.** Current controversies concerning the policies of the United States and other countries toward foreign investments by large business firms. First half of semester. Half-course. *Vaupel*

**133S. The Termination of Public Policy.** Case study approach to efforts to terminate public programs; process by which established programs acquire a political constituency and resulting difficulties. First half of semester. Half-course. *Behn*

**134S. Politics of Professions.** Professions as quasi-governments. Impact of licensing, certification, codes of ethics, and self-regulation on volume and quality of professional services. Mechanisms for achieving accountability to the public. First half of semester. Half-course. *Stone*

**140S. Behavior in Public Organizations.** Effect of political, social, and psychological factors on the behavior of public officials. Half-course. *Hawley*

**151. Administration of Justice.** Analysis of policy problems and conflicts involved in the operation of the criminal justice system. One course. *Cook and Stone*

**154. Communications Policy.** Analysis of policy problems and conflicts involved in governmental regulation of the communications media. One course. *DeVries and Lange*

**157. Health Policy.** Analysis of health care problems and policies. One course. *Lipscomb and Stone*

**160S. Energy Technologies and Their Social Impact.** Physical energy: fossil fuels, nuclear, and solar power. Social implications of its use. One course. *Wallace*

**171S. Family, Life Cycle, and Public Policy.** Examination of assumptions and politics that have led to existing family policy in complex societies. Implication of cross cultural analysis for the reformulation of public policies affecting family life. First half of semester. Half-course. *Stack*

**173S. Migrant Workers and Public Policy.** Public policy in agriculture, labor, health, education, and welfare related to the problems faced by migrant agricultural workers. Half-course. *Payne*

**174. Technology Assessment and Social Choice.** (Also listed as Engineering 174.) One course. *Garg*

**175S. The Palestine Problem and United States Public Policy.** Identification of Arab and Zionist perceptions; alternatives available to American decision-makers; interest group pressures on United States policies; historical analysis to the improvement of public policy. One course. *Kuniholm*

**176S. Documentary Photography and Public Policy.** Television, film, and still photography. One course. *Payne and Staff*

**180S. Writing for the Media.** Workshop on writing the new story, editorials, and features for the print media. One course. *Green*

**184S. Effect of Mass Media, Particularly Television, on Political Attitudes.** Impact of mass media. Research on various "theories" of the influence of the media. One course. *McConahay*

**186. Mass Media and Public Policy.** The media as a social and political institution in the shaping of public policy. Treatment of the news by editors and journalists to include economic, political, and professional concerns. One course. *Staff*

**190. Internship.** For students working in a public agency, political campaign, or other policy-oriented group under the supervision of a faculty member. Prerequisite: prior consent of Director of Undergraduate Studies. One course. *Staff*

**191, 192. Independent Study.** Directed reading and research. Up to two courses. *Staff*

**193, 194. Independent Study.** Directed reading and research for seniors. Up to two courses. *Staff*

**195S A-D. Seminar in Selected Public Policy Topics.** (Also listed as History 195.) One course each. *Staff*

#### For Seniors and Graduates

**204. Ethics in Political Life.** (Also listed as Political Science 204.) One course. *Spragens*

**216S. Comparative Politics of the Welfare State.** (Also listed as Political Science 216S.) One course. *Stone*

**217. Microeconomics and Public Policy-making.** Consumption and production theory, welfare economics, theories of collective choice, market structures and regulation, and nonmarket decision-making. One course. *Cook, Lipscomb, or Behn*

**219. The Politics of the Policy Process.** The formulation of public policy-



making, substantive policies in a variety of contexts from local government to international affairs; the role of legislatures, interest groups, executive branches, and the bureaucracy in defining alternatives and in shaping policy from agenda formulation to implementation. (Also listed as Political Science 248.) One course. *Salamon and Stone*

**221. Analytical Methods I: Decision Analysis for Public Policy-makers.** Methods for structuring decision dilemmas and decomposing complex problems, assessing the probabilities of uncertain consequences of alternative decisions, appraising the decision-maker's preferences for these consequences and for reexamining the decision. (Not open to students who have taken Public Policy Studies 55.) One course. *Blaydon, Fischer, or Behn*

**222. Analytical Methods II: Data Analysis for Public Policy-makers.** Sampling theory, Bayesian statistics, and regression analysis. Examples from problems in health care, transportation, crime, urban affairs, and politics. (Not open to students who have taken Public Policy Studies 112.) One course. *Behn, Fischer, or Vaupel*

**223S. Ethics and Policy-making.** Normative concepts in politics—liberty, justice, the public interest: historical and philosophical roots; relationship to one another and to American political tradition; and implications for domestic policy problems. (Also listed as Political Science 245S.) One course. *Price*

**224. Applications of Administrative and Organizational Theory.** (Also listed as Political Science 243.) One course. *Hawley*

**231. Analytical Methods III: Evaluation of Public Programs and Policies.** Theoretical treatment of cost-benefit analysis; discussion of several prospective and retrospective evaluations of public programs and policies. Examples from law enforcement, health, income maintenance and other policy areas. Prerequisites: Public Policy Studies 55 or Public Policy Sciences 221, 112 or 222, and 110 or 217, or Economics 149. One course. *Cook and Fischer*

**232. Analytical Methods IV: Regression and Simulation Techniques for Policy Analysis.** Topics: Statistical and simulation techniques appropriate for evaluation and projection in cases where the analyst has non-experimental data; positive and normative aspects of public regulation of the private sector. One course. *Staff*

**233. Analytic Approaches to Bargaining, Cooperation, and Competition.** Application of principles of game theory, economics, and psychology to labor-management negotiation, plea bargaining, public interest group formation, corporate collusion, business mergers, and arms limitations. One course. *Blaydon and Fischer*

**236S. Public Financial Management.** State and local governments. Budgetary requirements and fund raising. One course. *Blaydon*

**246. Population Policy.** (Also listed as Sociology 246.) One course. *Back*

**247. Political Participation and Policy Outcomes.** (Also listed as Political Sciences 247.) One course. *Hough*

**252S. National Security Policy.** Application of decision analysis and normative and organizational theory and historical systems, to major strategic decisions, and selected foreign policy issues. One course. *Fischer and Kuniholm*

**253. Psychological Approaches to Public Policy.** Contribution of psychological analysis to an understanding of social issues such as poverty, drug abuse, crime, crowding, and race relations, the ways problems are recognized, and why different

policy alternatives are selected, (e.g., those that "blame the victim"). (Also listed as Psychology 253.) One course. *McConahay*

**254. Transportation Planning and Policy Analysis.** (Also listed as Civil Engineering 216.) Prerequisite or corequisite: Civil Engineering 116 or consent of instructor. One course. *Behn*

**255. Science, Politics, and Government.** An examination of the structure and values of the scientific community; the mechanisms and strategies of government; and their mutual interdependence in American society. (Also listed as Psychology 261 and Sociology 261.) One course. *Bevan and McKinney*

**256. The Economics of Health Care.** Prerequisite: Economics 149 or equivalent or consent of instructor. One course. *Lipscomb*

**260S. Public Policy Research Seminar: The Administration of Justice.** Examination of public policy issues concerning the administration of justice. One course. *Staff*

**261S. Research Seminar: Health Policy.** Determinants and impacts of public policies designed to improve the equity and efficiency of health services. The supply and distribution of services; the cost of services and alternative modes of financing; the quality of services and alternative mechanisms of quality control. Applied research paper. One course. *Lipscomb and Stone*

**262S. Research Seminar in Communications.** Examination of public policy issues in the communications field. One course. *Lange*

**263S. Public Policy Research Seminar: Urban and Regional Development Policy.** Dynamics of urban and regional development analyzing alternative policy instruments for coping with the social, environmental, and economic effects. Housing, land use, transportation, taxation, environmental protection, and related urban development problems and policies. Prerequisite: Political Science 176, Political Science 109, Economics 234 or consent of instructor. One course. *Salamon*

**264S. Public Policy Research Seminar: Topics in Public Policy I.** Selected topics. One course. *Staff*

**270S. Humanistic Perspectives on Public Policy.** Modes of inquiry into aspects of social life important to policy-makers but beyond the normal reach of social science. Reading from James Agee, Robert Coles, Eudora Welty, James Baldwin, George Eliot, and others. Prerequisite: consent of instructor. One course. *Payne and Coles*

**271. The Uses of History in Public Policy I.** Introduction to historical analysis as a technique for formulating and evaluating public policy. (Also listed as History 203.) One course. *Goodwyn*

**272. Poverty in the United States: An Historical Perspective.** Social, political, and cultural origins and contemporary policy alternatives. (Also listed as History 272.) One course. *Decker*

**273. The Uses of History in Public Policy II.** Introduction to historical analysis as a technique for formulating and evaluating public policy. Emphasis on public policy decisions abroad since World War II, including the structuring of selected contemporary problems in light of their historical contexts. (Also listed as History 204.) One course. *Kuniholm*

**275. Class, Ethnicity, and Social Policy.** The uses of anthropological modes of analysis for understanding social issues and public policy with a focus on class,

work, ethnicity, sex roles, and the family. (Also listed as Anthropology 277.) One course. *Stack*

**283S. Congressional Policy-making.** (Also listed as Political Science 283S.) One course. *Price*

## INTERNSHIP COURSES

The internship courses provide students with an opportunity to develop a basic understanding of one or more public policy areas, to apply that understanding in a job during the summer and to return to the classroom to build on this knowledge and experience. Normally, students take a two-course sequence to receive credit for the field experience requirement of all public policy studies majors. Prior to participation in the internship program, all majors must have completed Public Policy Studies 55 and three of the four core courses (Public Policy Studies 110, 112, 114, or 116). This requirement may be waived by the Director of Undergraduate Studies for transfer students or others in unusual circumstances. Applications for enrollment in the internship program must be completed in the early fall through the Director of Internship Programs. Stipends are usually provided for all public policy majors enrolled in one of the summer internship courses listed below.

**152S. Administration of Justice.** Summer Internship. Prerequisite: Public Policy Studies 151. One course. *Staff*

**155S. Communications Policy.** Summer Internship. Prerequisite: Public Policy Studies 154. One course. *Staff*

**158S. Health Policy.** Summer Internship. Prerequisite: Public Policy Studies 157. One course. *Staff*

All majors are encouraged to take an advanced follow-up course in the area of their summer internship.

## THE MAJOR

*Prerequisites.* Economics 2 or 52, Political Science 91, and Public Policy Studies 55.

*Major Requirements.* Public Policy Studies 110, 112, 114, 116, plus three additional courses one of which must be a 200-level course. A policy-oriented field experience approved by the Director of Undergraduate Studies is required.

## Religion

Professor Poteat, *Chairman*; Professor Osborn, *Director of Undergraduate Studies*; Professors Bradley, Jones, Lincoln, Long, Phillips, Price, and Wintermute; Associate Professors Charlesworth, Corless, Kort, Lawrence, McCollough, Meyers, and Partin; Assistant Professors Bland and Burford; Lecturers Churchill, Meyers, and Shows

Study in the Department of Religion should arise from or lead to the awareness that an understanding of religion is crucial to an understanding of persons and of human societies. The curriculum is designed to develop this understanding in two distinct but inseparable ways; first, through the examination of the particulars of specific religious traditions; and, second, through theoretical studies of an analytic, comparative, and constructive nature.

Introductory courses (Religion 50, 51, 52, 55, 56, 57, 58, and 59) are open to all undergraduates. These courses also help fulfill distributional requirements for the

religion major and are therefore cross-listed at the head of appropriate divisions of the curriculum. One-hundred level courses normally are open to juniors and seniors without prerequisite. Freshmen and sophomores who have completed one course below 100 may be admitted to 100-level courses with the exception of junior-senior seminars. Courses at the 200-level are open to upperclassmen with the consent of the instructor.

## INTRODUCTORY COURSES

**50. The Old Testament.** Historical, literary, and theological investigations. Not open to students who have had Religion 55 or 55D. One course. *Staff*

**51. Introduction to Judaic Civilization.** Continuity and change in the major periods of Judaism. One course. *Bland or Meyers*

**52. The New Testament.** Origins, development, and content of thought. Not open to students who have had Religion 55 or 55D. One course. *Staff*

**55. The Religion of the Bible.** A historical, cultural, and theological study of the Old and New Testaments. Not open to students who have had Religion 50, 50D, 52, 52D. One course. *Staff*

**50D, 52D, 55D.** Same as 50, 52, 55 with discussion section included. One course each. *Staff*

**56. The Black Religious Experience in America.** From the slave period to the present. One course. *Lincoln*

**57. Introduction to Religions of Asia.** Problems and methods in the study of religion, followed by a survey of the historical development, beliefs, practices, and contemporary significance of the Islamic religion and religions of South and East Asia. One course. *Staff*

**58. Interpretations of Religion in Western Culture.** Western religion as explained by contemporary sociologists, psychologists, anthropologists, and theologians. One course. *Staff*

**59. Problems in Theology and Ethics.** Philosophical, theological, and cultural problems, such as the existence of God, ethical theory, religious language, and the relation of religion to culture. One course. *Staff*

## RELIGIOUS TRADITIONS: THEIR ORIGINS AND DEVELOPMENT

### African and Asian Traditions

Introductory Course 57.

**71A, 72A. Freshman-Sophomore Seminars: African and Asian Traditions.** Topics and instructors to be announced. Two courses. *Staff*

**113. African Philosophy.** (Also listed as Black Studies 113.) One course.

**140. Religions of India.** Major religious traditions of the subcontinent. Hinduism, Buddhism, Jainism, and Islam. One course. *Bradley or Lawrence*

**141. Religions of China and Japan.** Traditional religion in China and Japan and its interaction with Sino-Japanese Buddhism. One course. *Corless*

**147. Muhammad and the Qur'ān.** The Qur'ān in relation to the religious experience, life, and work of Muhammad. One course. *Partin*



**149. Buddha and Buddhism.** A systematic introduction to the origins and spread of Buddhist thought and practice. One course. *Corless*

**152. Islamic Mysticism.** Sufism as an ascetical protest movement that affected the worldwide growth of Islam. One course. *Lawrence*

**160, 161. Introduction to the Civilizations of Southern Asia.** (Also listed as Interdisciplinary Courses 101, 102.) Two courses. *Lawrence*

**195A, 196A. Junior-Senior Seminars: African and Asian Traditions.** Topics and instructors to be announced. Two courses. *Staff*

**217. Islam in India.** History and thought of major Indian Muslims from Biruni to Wali-Ullah, with special attention to the role of Sufism. An introduction to selected Muslim scholars and saints who contributed to the interaction between Islam and Hinduism in Northern India during the second millenium A.D. One course. *Lawrence*

**218. Religion in Japan.** A survey of religion in Japan, with specific emphasis on indigenization and attempts at synthesis. An approach to the meaning of the words *religious* and *secular* in the Japanese situation. One course. *Corless*

**265. Religions of the West Africa Diaspora.** Religious development of Africans displaced to the Western Hemisphere by slavery. One course. *Lincoln*

**284. The Religion and History of Islam.** Origins and development of the Islamic community and tradition, with particular attention to the religious element. One course. *Partin*

**285. The Vedic Tradition: Compilation and Interpretation.** Indian canonical writings with emphasis on the literary stages in relation to later philosophical and religious movements. One course. *Lawrence*

**286. Religious Trends in the Indian Subcontinent.** Leaders and movements among the religions from the coming of the Europeans to Independence. One course. *Bradley*

**287. Scriptures of Asia.** Intensive study of translations of basic texts from the religious traditions of India, China, and Japan. One course. *Bradley*

**288. Buddhist Thought and Practice.** An historical introduction to Buddhist thought and practice, with special attention to their interrelationship in the living religion. One course. *Corless*

### **Jewish and Christian Traditions**

Introductory Courses 50, 51, 52, 55, and 50D, 52D, 55D.

**71B, 72B. Freshman-Sophomore Seminars: Jewish and Christian Traditions.** Topics and instructors to be announced. Two courses. *Staff*

**104. The Prophets of the Old Testament.** Their historical setting and message. One course. *Wintermute*

**105. Theology of the Old Testament.** Emphasis upon history and eschatology, covenant, messianism, and wisdom. One course. *Wintermute*

**106. Jesus and the Synoptic Gospels.** The gospel tradition in the New Testament. One course. *Charlesworth*

**107. Theology of the New Testament.** A systematic analysis of the theologies

of the New Testament writers and an attempt to synthesize the basic and shared themes. One course. *Charlesworth or Price*

**108. The Life and Letters of Paul.** Paul's role in the expansion of the Christian movement, the most important aspects of his thought, and his continuing influence. One course. *Price*

**111. The Historical Jesus.** Historical research on the life of Jesus. One course. *Charlesworth or Price*

**115-116. Introduction to Biblical Hebrew.** (Divinity School courses open to undergraduates with permission of the instructor.) Elements of phonology, morphology, and syntax. Exercises in reading and writing Hebrew. Second semester: study of the weak verb; exegetical treatment of the Book of Jonah. Two courses. *Bailey*

**120. History of the Christian Church.** Crucial events, issues, forms, and writings that have shaped the Christian community and influenced Western civilization from the time of the early church. One course. *Staff*

**122. Protestantism and Catholicism in Modern Europe.** Reformation and Counter-Reformation, confessionalism, religious conflicts, and the secularization of European Christianity. One course. *Staff*

**124. Christianity in America.** Representative men, movements, and thought in American Christianity. One course. *Jones*

**128. The Background of Contemporary Christian Thought: 1918-1960.** Theology of Karl Barth, Rudolf Bultmann, Paul Tillich, Karl Rahner, Reinhold Niebuhr, and others. One course. *Osborn*

**129. Contemporary Christian Thought, 1960 to the Present.** Trends in contemporary theology, such as secular theology, theology of hope, and liberation theology. One course. *Osborn*

**131D. Principles of Archeological Investigation.** Supervised field work, visits to other excavations, introduction to ceramic chronology, numismatics, and other related disciplines. Excavation of a late Roman village in Galilee. Offered in Israel, only in the summer. (Also listed as Anthropology 131D.) One course. *Meyers*

**132D. Palestine in Late Antiquity.** The history, literature, and archeology of Roman Palestine with particular emphasis on Galilee in rabbinic and early Christian times. One course. *Meyers*

**133. The Foundations of Post-Biblical Judaism.** History, religion, and literature of Pharasaic and sectarian Judaism from the time of Ezra to Rabbi Judah. One course. *Meyers*

**134. Jewish Mysticism.** The main historical stages, personalities, texts, and doctrines from rabbinic to modern times. One course. *Bland*

**135. Jewish Religious Thought.** Doctrines, dialectics, and religious attitudes of pre-Enlightenment theologians. One course. *Bland*

**136. Contemporary Jewish Thought.** Modern Jewish thought from Mendelssohn to the present, with particular reference to American thinkers. One course. *Meyers*

**137. Jewish Ritual and Theology.** Introduction to thought and practice as reflected in the historical and literary development of *The Prayer Book*. One course. *Bland*

**139. Modern Hebrew.** Representative texts from the modern period, with an introduction to the colloquial language of Israel. One course. *Staff*

**145. Religious Quests of the Greco-Roman World.** Sectarian Judaism, the Mystery Cults, and Gnosticism. One course. *Wintermute*

**195B, 196B. Junior-Senior Seminars: Jewish and Christian Traditions.** Topics and instructors to be announced. Two courses. *Staff*

**207, 208. Second Hebrew.** Historical Hebrew grammar with reading and exegesis of Old Testament prose and poetry. (Also listed as OT 207, OT 208 in the Divinity School.) Prerequisite: at least one year of Hebrew or consent of the instructor. Two courses. *Staff*

**220. Third Hebrew.** An interpretive study of late Hebrew prose, with readings from *Chronicles*, *Ecclesiastes*, and the *Mishnah*. One course. *Meyers*

**221. Readings in Hebrew Biblical Commentaries.** Selected Hebrew texts in Midrash, Aggadah, and other Hebrew commentaries reflecting major trends of classical Jewish exegesis. One course. *Bland*

**226B. Exegesis of the Greek New Testament (Romans).** Prerequisite: consent of instructor. One course. *Price*

**226D. Exegesis of the Greek New Testament.** Prerequisite: consent of the instructor. One course. *Price or M. Smith*

**239. Introduction to Middle Egyptian.** Grammar and readings in hieroglyphic texts relating to the Old Testament. One course. *Wintermute*

**244. The Archeology of Palestine in Hellenistic-Roman Times.** The study of material and epigraphic remains as they relate to Judaism in Hellenistic-Roman times, with special emphasis on Jewish art. One course. *Meyers*

**248. Theology of Karl Barth.** A historical and critical study of Barth's theology. One course. *Osborn*

**258. Coptic.** Introduction to the Sahidic dialect with selected readings from Christian and Gnostic texts. Prerequisite: one year of Greek or consent of the instructor. One course. *Wintermute*

Students interested in acquiring additional linguistic tools required for graduate courses in Biblical studies are referred to the offerings of the Classical Studies Department for elementary Greek and the *Divinity School Bulletin* for courses in Aramaic.

## ANALYTIC, COMPARATIVE, AND CONSTRUCTIVE STUDIES

Introductory Courses 56, 58, and 59.

**71C, 72C. Freshman-Sophomore Seminars: Analytic, Comparative, and Constructive Studies.** Topics and instructors to be announced. Two courses. *Staff*

**126. Themes in Christian Theology.** A study of basic Christian teachings. One course. *Osborn*

**130. Christian Ethics.** Ethical implications of Biblical religion, the historical development of Christian ethics, and the ethical dimensions of contemporary social life. One course. *McCollough*

**138. Political Leadership and the Black Church.** Turner, Powell, King, Malcolm X, and others. One course. *Lincoln*

**142. Myth and Symbol.** Historical and phenomenological study of religious myths and symbols. One course. *Partin*

**143. Mysticism.** The mystical element of religion: Hinduism, Buddhism, Christianity, and Islam. One course. *Bradley*

**144. Black Cults and Sects in America.** Cult-sect phenomena. One course. *Lincoln*

**146. Modalities of the Sacred.** Analysis of the structure of hierophanies in relation to religious and cultural history. One course. *Long*

**150. Religion and Human Sexuality.** A study of the current sexual revolution with the aim of examining options and determining relevant Judaic and Christian attitudes and actions. One course. *Phillips*

**151. Ethical Issues in Social Change and Public Policy.** American moral tradition and factors in social change in the normative analysis of public policy, with a consideration of specific ethical issues. One course. *McCollough*

**155. Ethical Issues in the Life Cycle.** Human development viewed in religious, ethical, and psychological perspectives. One course. *McCollough*

**156. Christian Marriage and the Family.** Marriage and the family in American society studied from the Christian perspective. One course. *Phillips*

**158. Psychology and Religion.** Contributions of major psychological theories to an understanding of religion, especially Christianity. One course. *Shows*

**170. Problems of Religious Thought.** Analysis of credentials for belief in God. One course. *Poteat*

**178. Existentialism.** Religious roots, development, and contemporary expressions. One course. *Burford*

**187. Religious Elements in Classical and European Literature.** A consideration of the religious elements in representative writings. One course. *Kort*

**188. Recent Literature and its Religious Implications.** Religious elements in recent literature. One course. *Kort*

**195C, 196C. Junior-Senior Seminars: Analytic, Comparative, and Constructive Studies.** Topics and instructors to be announced. Two courses. *Staff*

**212. Policy-making and Theological Ethics.** Relation of knowledge, power, and values in policy-making; models of decision-making in the policy sciences and their ethical implications. One course. *McCollough*

**232. Religion and Literature: Perspectives and Methods.** Selected literary works as interpreted by myth or archetype critics and by theological critics. One course. *Kort*

**233. Modern Narrative and Religious Language.** Fiction of selected American, British, and Continental writers of the first half of the twentieth century, with special attention to the role of religious language in their work. One course. *Kort*

**238. Jewish Responses to Christianity.** Apologetic and polemical themes in rabbinic, medieval, and contemporary writings. One course. *Bland*



**264. The Sociology of the Black Church.** An effort to identify, define, describe, and interpret the Black Church. One course. *Lincoln*

**265. Religions of the West Africa Diaspora.** Religious developments of Africans displaced to the Western Hemisphere by slavery. One course. *Lincoln*

**272S. Topics in Comparative Theology.** Theological categories in Christian and Eastern religious traditions, focusing on such topics as man, God, salvation and eschatology. One course. *Lawrence and Osborn*

**280. The History of Religions.** A study of the methodology of the history of religions, the nature of religious experience, and specific categories of religious phenomena. One course. *Partin*

**282. Myth and Ritual.** Historical and phenomenological study of myth and ritual in their interrelationships in the history of religions, with particular attention to religious pilgrimage. One course. *Partin*

**286. Religious Trends in the Indian Subcontinent.** Leaders and movements among the religions from the coming of the Europeans to Independence. One course. *Bradley*

## INDEPENDENT STUDY

**191, 192. Independent Study.** For freshmen and sophomores with departmental approval. Two courses. *Staff*

**193, 194. Independent Study.** For juniors and seniors with departmental approval. Two courses. *Staff*

**197-198. Honors Research.** Consent of the Director of Undergraduate Studies required. Two courses. *Staff*

## DEPARTMENTAL MAJOR

**Major Requirements.** Eight courses, which must include at least two introductory courses (numbered 50 through 59). The distribution of courses must also include at least one each from the categories "African and Asian Traditions," "Jewish and Christian Traditions," and "Analytic, Comparative, and Constructive Studies." One of the eight courses must also be a junior-senior seminar or a 200-level course.

The student, in consultation with an assigned adviser and with the adviser's approval, should elect four of the eight courses in such a way that they will constitute a thematic or methodological concentration on a particular aspect of religion.

The Department of Religion has been well aware in designing its major program that the majority of students electing to major in religion are seeking a liberal arts education. Therefore the students take courses in at least two religious traditions as well as in the area of analytic, comparative, and constructive studies, and are encouraged to take a wide range of electives or to focus them to reflect their own developing interests.

To prepare for graduate or professional study of religion, the Department of Religion recommends that majors complete at least two years of college-level study, or the equivalent, of a foreign language. Master of Arts and Doctor of Philosophy programs often require examination in one or two foreign languages. Students planning to attend a theological seminary should note that knowledge of Biblical languages, as well as Latin, frequently is presupposed or required. Those planning to pursue studies of Asian religions should begin appropriate language study as part of their undergraduate preparation.

*Honors.* The department offers work leading to graduation with distinction. For further information consult the Director of Undergraduate Studies in Religion and the section on Honors in this *Bulletin*.

## Reserve Officers Training Program

### AIR FORCE AEROSPACE STUDIES

Professor Dutton, Lt. Colonel, USAF, *Chairman*; Assistant Professor Vesel, Captain, USAF, *Director of Undergraduate Studies*; Assistant Professors Griffin, Major, USAF; and Spencer, Captain, USAF.

**Eligibility Requirements.** All freshmen, male or female, are eligible to enroll in the General Military Course in the Air Force ROTC. For enrollment in the Professional Officer Course, the student must have completed successfully either the General Military Course or the six-weeks Field Training Course; must execute a written agreement with the government to complete the Professional Officer Course; must be sworn into the enlisted reserve; and must agree to accept a commission in the United States Air Force Reserve upon graduation.

**Deposit.** Each student must make a deposit of ten dollars with the Bursar's Office to ensure return of all government property.

### General Military Courses

#### *First Year*

**1. United States Military Forces in the Contemporary World.** Development of aerospace power in the United States; mission, doctrine, and organization of the United States Air Force; and its relationship to the other services within the Department of Defense. (May not be counted to satisfy graduation requirements.) Half-course. *Dutton*

**4. Corps Training.** No course credit. *Staff*

#### *Second Year*

**51. Development of Air Power.** Growth and development of air power from dirigibles and balloons to the present; emphasizing evolution of concepts and doctrine governing air power employment in support of national objectives. (May not be counted to satisfy graduation requirements.) Half-course. *Spencer*

**54. Corps Training.** No course credit. *Staff*

### Professional Officer Courses

All students selected to continue aerospace studies pursue the following courses:

#### *First Year*

**104. Corps Training.** No course credit. *Staff*

**105S. Aerospace Leadership and Management.** An introduction to management fundamentals to include the knowledge base and process of managing. One course. *Griffin*

**106S. Aerospace Leadership and Management.** Application of management

fundamentals to duties as junior officers/executives to include principles of leadership and military law. One course. *Griffin*

## *Second Year*

**203. The Problems of Flight and Aerospace Sciences of Weather and Navigation.** Mandatory for pilot and navigator cadets; approval of instructor for all others. Half-course. *Vesel*

**204. Corps Training.** No course credit. *Staff*

**205S. National Security Forces in Contemporary American Society.** Current questions of the role and function of the professional military officer in a democratic society and the complex relationships in civil-military interactions. One course. *Vesel*

**206S. National Security Forces in Contemporary American Society.** Formulation and implementation of American defense policy. One course. *Vesel*

## NAVAL SCIENCE

Professor Hayes, Captain, U.S. Navy, *Chairman*; Visiting Associate Professor Krause, Commander, U.S. Navy, *Director of Undergraduate Studies*; Visiting Assistant Professors Bell, Major, U.S. Marine Corps; Watkins, Lieutenant, U.S. Navy; Waters, Lieutenant, U.S. Navy; Visiting Part-time Instructor Whiteway, Lieutenant, U.S. Navy

Completion of all naval science courses listed is required for a commission. A maximum of four naval science courses may be offered as electives in satisfying degree requirements in Trinity College; only two naval science courses (junior or senior level) can be so offered in the School of Engineering. Fifteen hours of practical and applied leadership are required each semester.

**11L. Naval Orientation.** Military formations, movements, commands, courtesies, and honors; and elements of unit leadership. *Waters*

**12. Naval Ships Systems.** Structure, elements of design, stability, compartmentation, communications, and propulsion systems as they bear on safe operation and combat or service effectiveness. One course. *Waters*

**51, 52. Seapower and Maritime Affairs Seminar.** Strategic, tactical, and diplomatic aspects of seapower. *Bell*

**70P. Naval Organization and Management.** Lines of command and control; organization for logistics, service, and support; research on the practical application of fundamental management principles at lower echelons of Navy management structure. (Required preceptorial for NROTC students taking Management Sciences 70.) *Whiteway*

**126. Concepts and Analyses of Naval Tactical Systems.** Detection systems, offensive and defensive capabilities. One course. *Watkins*

**131. Navigation.** Theory, principles, and procedures of ship navigation, movements, and employment. Dead reckoning, piloting, and electronic and principles of navigation as presented in the lecture series. Naval Science 131L is a concurrent requirement. One course. *Watkins*

**131L. Navigation Laboratory.** Practical application of the theories and principles of navigation as presented in the lecture series. *Watkins*

**132. Naval Operations.** Components of general naval operations, including

concepts and application of tactical formations and dispositions, relative motion, maneuvering board, and tactical plots, rules of the road, and naval communications. Naval Science 132L is a concurrent requirement. One course. *Watkins*

**132L. Naval Operations Laboratory.** Practical application of the theories of naval operations as presented in the lecture series. *Watkins*

**141. Evolution of Warfare.** A survey of the development of weaponry, tactics, and strategy affiliated with warfare, as exemplified by the confrontations selected for detailed study through World War II. One course. *Bell*

**146L. Naval Ship Administration Laboratory.** Management and organizational concepts in shipboard command and control. *Krause*

**151. Amphibious Operations.** An examination of the development of U.S. amphibious doctrine, with emphasis on current applications of that doctrine. One course. *Bell*

## Romance Languages

Professor Tetel, *Chairman*; Assistant Professor Bryan, *Director of Undergraduate Studies in French*; Professor Garci-Gómez, *Director of Undergraduate Studies in Spanish*; Associate Professor Hull, *Supervisor of Language Instruction*; Professors Cordle, Fein, Fowlie, Niess, Predmore, and Wardropper; Associate Professors Ripley, Stewart, and Vincent; Assistant Professors Barlow, Caserta, Hedges, Melzer, and Miller; Instructor Santi

French 63, 74 and Spanish 63, 74 or equivalent are the prerequisites for all courses not taught in English. Students who, by reason of foreign residence, have had special opportunities in French or Spanish must be classified by the appropriate Director of Undergraduate Studies.

The intensive language courses 181, 182 are recommended for students who wish to acquire proficiency in a second foreign language before entering graduate school.

In literature, one credit is granted for a score of 3 or 4 and two credits for a score of 5 (French or Spanish 70, 71) in the examination of the Advanced Placement program. In language one advanced placement credit (French or Spanish 76) is granted for scores 3-5.

## FRENCH

### Literature in English Translation

**113. Society and the Novel in Modern France.** Social structure and realities in fiction, beginning with the seventeenth century. One course. *Stewart*

**116. The Nineteenth-Century Novel.** Stendhal, Balzac, Flaubert, and Zola. One course. *Niess*

**151. Theory and Form of Tragedy.** A study of major theorists and an analysis of principal Greek, French, and English tragedies. One course. *Fowlie*

**217. French Symbolism.** (See listing below under French Literature.) *Fowlie*

**228. French Poetry of the Twentieth Century.** (See listing below under French Literature.) *Fowlie*

**233. Contemporary French Theater.** (See listing below under French Literature.) *Fowlie*



234. Proust. (See listing below under French Literature.) Fowlie

## Language and Civilization

1-2. **Elementary French.** Understanding, speaking, reading, and writing French. Language laboratory available for recording-listening practice. Two courses. *Hull and Staff*

63. **Intermediate French.** Grammar review, reading, and oral practice, including laboratory experience. One course. *Hull and Staff*

74. **Intermediate Readings in Modern French.** Readings, discussion, composition, listening practice. One course. *Hull and Staff*

76. **Introductory French Conversation.** Practice in everyday conversational French. Prerequisite: French 63 or equivalent. Enrollment: maximum fifteen students. One course. *Bryan and Staff*

100. **Active French.** Conversation and *exposés* on contemporary subjects. Prerequisite: French 76 or equivalent or consent of instructor. One course. *Bryan and Staff*

125. **The French of Canada.** The language of the French Canadians: its origins, history, and present status; psycholinguistic and sociolinguistic problems; bilingualism in Canada. Lectures and reports in English; readings in English and French. Prerequisite: French 74 or equivalent, or consent of instructor. One course. *Hull*

126. **French Phonetics.** Sounds, rhythm, intonation. Individual practice in language laboratory. Readings in phonetic theory. One course. *Hull*

127S. **Advanced Composition and Conversation.** Prerequisite: French 100. Not open to freshmen. One course. *Bryan*

128. **Advanced Grammar and Translation.** Differences between French and English patterns of expression. Practice in translation. Prerequisite: French 100 or equivalent. One course. *Hull*

129. **Foundations of French Civilization.** Its development up to the Revolution of 1789 in relation to European culture. Readings and discussions in French. One course. *Tetel*

130. **Modern French Civilization.** Nineteenth- and twentieth-century France, history, institutions, customs, and arts. Readings and discussions in French. One course. *Tetel*

150T. **Tutorial in Composition.** Half-course. *Barlow*

181. **Intensive French.** An introduction to the language. Prerequisite: four semesters of another foreign language or consent of instructor. One course. *Ripley*

182. **Intensive French.** Readings in modern literature: analysis and discussion. Prerequisite: French 181 or consent of instructor. One course. *Ripley*

210. **The Structure of French.** Modern French phonology, morphology, and syntax. Readings in current linguistic theory. One course. *Hull*

224. **History of the French Language.** The evolution of French from Latin to its present form; internal developments and external influences. One course. *Hull*

## Literature

70, 71. (These numbers represent one or two course credits for advanced placement in literature.)

**101, 102. Introduction to French Literature.** An introduction to the major writers of the French literary tradition. Selections and complete works of poetry, fiction, theater, and essay. In the first semester: Middle Ages through the eighteenth century. In the second semester: nineteenth and twentieth centuries. Lectures and discussions; short essays and tests. Conducted in French. Two courses. *Fowlie and Staff*

**103S, 104S. French Literature.** Topics to be announced. Open only to freshmen and sophomores. Two courses. *Staff*

**105. Explication de Texte.** A study of the French method of textual analysis, with selections primarily from nineteenth and twentieth-century authors. For students who have taken French 101 or 102. One course. *Staff*

**106S. Montaigne.** A close reading of selected *Essais* aiming to integrate themes, structure, and style; frequent comparative allusions will be made to Proust, Pirandello, Malraux, and Sartre. One course. *Tetel*

**107S. Perspectives in Criticism.** Readings and discussion. Open only to freshmen and sophomores through the Advanced Placement Program or by invitation of the Director of Undergraduate Studies. One course. *Stewart*

**108. Romanticism in French Literature.** Romantic theory and novelists including Constant, Stendhal, and Balzac; representative poets and dramatists including Lamartine, Hugo, Musset, and Vigny. One course. *Niess*

**109. Toward Modernism in French Poetry.** An introduction to modern trends in the nineteenth century; emergence from traditional romanticism; Art for Art's Sake and Parnassians (Gautier, Leconte de Lisle); the transition from decadence to symbolism (Baudelaire, Verlaine, Rimbaud, and Mallarmé). One course. *Barlow*

**110. French Comedy in the Seventeenth and Eighteenth Centuries.** The theatrical tradition of comedy and its evolution; readings from Corneille, Molière, Lesage, Marivaux, and Beaumarchais. One course. *Stewart*

**111. French Drama of the Nineteenth Century.** A survey of the French theater from the Romantic period to the *Théâtre libre*. One course. *Niess*

**112. French Drama of the Twentieth Century.** A survey of literature for the stage from 1890 to the present. One play each of Claudel, Maeterlinck, Jarry, Giraudoux, Cocteau, Ghelderode, Anouilh, Montherlant, Sartre, Camus, Genet, Ionesco, Beckett, Pinget, Vian, Arrabal. One course. *Cordle*

**114S. The Sixteenth Century.** An introduction to the spirit of the French Renaissance as reflected in the literature of the age of Rabelais and Montaigne, Ronsard, and Du Bellay. One course. *Tetel or Vincent*

**115. Realism and Naturalism in French Literature.** Flaubert, Maupassant, and Zola. One course. *Niess*

**117S. Masterpieces of French Medieval Literature.** Lyric poetry, epic romance, and theater from beginning to the middle French period. One course. *Ripley*

**119. French Drama of the Seventeenth Century.** The plays of Corneille, Racine, and Molière are used to explore tragedy and comedy. One course. *Melzer*

**120. Seventeenth-Century Poetry, Novel, and Rhetoric.** Analysis of form and thought in selected works of La Fontaine, Mme. de La Fayette, Pascal, La Rochefoucauld, and La Bruyère. One course. *Melzer*

**121. The French Enlightenment.** Religion, politics, and philosophic and literary ideas of eighteenth-century France: Montesquieu, Voltaire, Rousseau, and others. One course. *Stewart*

**122. The Early French Novel.** The rise of the novel as a literary form up to the Revolution. Readings from D'Urfé, Scarron, Mme. de La Fayette, Furetière, Montesquieu, Prevost, Marivaux, Diderot, Rousseau, Laclos. One course. *Stewart*

**132. French Poetry of the Twentieth Century.** The symbolist heritage and surrealism. One course. *Barlow*

**133, 134. Contemporary French Life and Thought.** Major writers of the twentieth century and their historical and cultural circumstances. First semester: Claudel, Gide, Valéry, Proust, Apollinaire, Mauriac, Alain-Fournier, Cocteau. Second semester: Giono, Breton, Aragon, Malraux, Sartre, Beckett, Camus, Robbe-Grillet, Sarraute. Two courses. *Cordle*

**136. Film and the French Novel.** Relationship between film and the novel in twentieth-century French culture: surrealism (Breton, Clair, Léger), *nouveau roman* (Resnais, Duras, Robbe-Grillet), avant-garde (Sollers, Roche, Marker). One course. *Hedges*

**137. The French Film.** Evolution of techniques and styles from 1895 to the present. Fourteen directors from the silent (Méliès, Dulac, Bunuel) as well as from the sound era (Renoir, Carne, Truffaut). One course. *Hedges*

**141S, 142S. French Literature.** Topics to be announced. Open to juniors and seniors. Two courses. *Staff*

**152. André Gide: the Art of Fiction and Autobiography.** Gide's major works and his use of Greek myths with a comparative study of these myths in English and German literatures. Readings in French or English. One course. *Fowlie*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified juniors by consent of instructor and the Director of Undergraduate Studies. Two courses. *Staff*

**193, 194. Independent Study.** Directed reading and research. Open only to qualified seniors by consent of the instructor and of the Director of Undergraduate Studies. Two courses. *Staff*

**213. French Literature of the Seventeenth Century.** The Baroque and the Classical: form and meaning in the plays of Corneille, Racine, and Molière. Readings in baroque and *précieux* poetry. One course. *Melzer*

**214. The "Moralistes" of the Seventeenth Century.** Rise of modernity. Form and meaning in the works of Descartes, Pascal, La Rochefoucauld, La Fontaine, La Bruyère, Fénelon, and Mme. de Sévigné. One course. *Melzer*

**217. French Symbolism.** Poetry and theories of Baudelaire, Mallarmé, and Rimbaud; Decadence; Lautréamont, and Laforgue. One course. *Fowlie*

**219. Old French Literature.** An introduction to the reading of medieval French literary texts. One course. *Vincent*

**220. French Pre-Romantic and Romantic Poetry.** Chénier, Vigny, Lamartine, Musset, Hugo, and Nerval. One course. *Niess*

**221, 222. The Nineteenth-Century French Novel.** First semester: Romanticism and Romantic Realism, studied especially in the works of Chateaubriand, Stendhal,

and Balzac. Second semester: Realism and Naturalism, with special emphasis on Flaubert and Zola. Two courses. *Niess*

**225. French Prose of the Sixteenth Century.** Readings principally from Rabelais, Marguerite de Navarre, and Montaigne. One course. *Tetel*

**226. French Poetry of the Sixteenth Century.** A critical appraisal of Villon, Marot, the Ecole Lyonnaise, the Pléiade, and the "Baroque Poets." One course. *Tetel*

**228. French Poetry of the Twentieth Century.** In the wake of symbolism: Valéry and Claudel; poetry as ritual: Péguy; Apollinaire and surrealist poetry; the contemporary movement: Michaux, Char, Saint-John Perse. One course. *Fowlie*

**233. Contemporary French Theatre.** A study of dramatic theory; the art of the leading directors; and the major texts of Claudel, Giraudoux, Anouilh, Sartre, Beckett, Ionesco, and Genet. One course. *Fowlie*

**234. Proust.** A study of *A la recherche du temps perdu*. The thematic structure and the aesthetics of the work. One course. *Fowlie*

**241, 242. French Literature of the Eighteenth Century.** First semester: the Enlightenment, including Montesquieu, Voltaire, Diderot, Rousseau, and the *Encyclopédie*. Second semester: the development of literary forms, with emphasis on the theater and the novel. Two courses. *Stewart*

**245, 246. French Literature of the Twentieth Century.** First semester: to 1935, emphasis on Gide, Mauriac, and Malraux. Second semester: after 1935, emphasis on Sartre, Camus, and the *nouveau roman*. Two courses. *Cordle*

## ITALIAN

### Literature in English Translation

**141, 142. Masterworks of Italian Literature.** First semester: from the origins to the Baroque. Second semester: Ottocento and Novecento. Two courses. *Caserta*

**284. Dante.** (See listing below under Italian Literature.) *Fowlie*

**285. Dante.** The *Purgatorio* and the *Paradiso* in the light of Dante's cultural world. Special attention will be given to the poetic significance of the *Commedia*. Prerequisite: Italian 284 or equivalent. One course. *Caserta*

### Language and Civilization

**1-2. Elementary Italian.** Understanding, speaking, reading, and writing Italian. Language laboratory available for recording-listening practice. Two courses. *Caserta and Staff*

**63. Intermediate Italian.** Grammar review; reading; oral practice, including laboratory experience. One course. *Caserta and Staff*

**74. Intermediate Readings in Modern Italian.** Readings, discussion, composition, listening practice. One course. *Caserta and Staff*

**100. Spoken Italian.** Intensive instruction in contemporary Italian using selected topics and readings to build vocabulary and to provide practice in structural patterns. One course. *Caserta*

**129. Modern Italy.** Political, social, economic, and cultural problems in Italian history from 1861 to the present day. One course. *Caserta*



**181. Intensive Italian.** An introduction to the language. Prerequisite: four semesters of another foreign language or consent of instructor. One course. *Caserta*

### Literature

**182. Intensive Italian.** Readings in modern literature: analysis and discussion. Prerequisite: Italian 181 or consent of instructor. One course. *Caserta*

**183, 184. Readings in Italian Literature.** Historical and critical analysis. First semester: Dante, Petrarch, Boccaccio, and the Humanists. Second semester: Foscolo, Manzoni, Leopardi, and Verga. Conducted in Italian. Two courses. *Caserta*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified juniors by consent of instructor and of the Director of Undergraduate Studies. Two courses. *Staff*

**193, 194. Independent Study.** Directed reading and research. Open only to qualified seniors by consent of instructor and the Director of Undergraduate Studies. Two courses. *Staff*

**283. Italian Novel of the Novecento.** Representative novelists from Svevo to the most recent writers. One course. *Caserta*

**284. Dante.** *La Vita Nuova* and a close reading of the *Inferno*. Conducted in English. Reading in Italian or English. One course. *Fowlie*

**285. Dante.** The *Purgatorio* and the *Paradiso* in the light of Dante's cultural world. Special attention will be given to the poetic significance of the *Commedia*. Prerequisite: Italian 284 or equivalent. One course. *Caserta*

**288. The Renaissance.** Petrarch, Boccaccio, and Ariosto. One course. *Tetel*

## PORTUGUESE

### Language and Civilization

**181. Brazilian Portuguese.** An intensive introduction to the language. Prerequisite: four semesters of another foreign language or consent of instructor. One course. *Miller*

**185, 186. Conversation.** Practice in spoken Brazilian Portuguese. Prerequisite: Portuguese 182 or consent of instructor. Two courses. *Miller*

### Literature

**182. Contemporary Brazilian Theater.** Authors studied include Jorge Andrade, Ariano Suassuna, and Dias Gomes. Prerequisite: Portuguese 181 or consent of instructor. One course. *Miller*

**183. Readings in Modern Brazilian Literature.** Prerequisite: Portuguese 182 or consent of instructor. One course. *Miller*

**184. Literature of the Explorations: Asia, Africa, Latin America.** Prerequisite: Portuguese 182 or consent of instructor. One course. *Miller*

**191, 192. Independent Study.** Directed reading and research. Prerequisites: junior standing and consent of instructor and Director of Undergraduate Studies. Two courses. *Miller*

**193, 194. Independent Study.** Directed reading and research. Prerequisites:

senior standing and consent of instructor and Director of Undergraduate Studies. Two courses. *Miller*

## SPANISH

### Literature in English Translation.

**157. Latin American Literature.** Fictional and poetic works of the last thirty years that have made an impact on world literature. One course. *Fein*

### Language and Civilization

**1-2. Elementary Spanish.** Understanding, speaking, reading, and writing Spanish. Language laboratory available for recording-listening practice. Two courses. *Miller and Staff*

**63. Intermediate Spanish.** Grammar review; reading; oral practice, including laboratory experience. One course. *Miller and Staff*

**74. Intermediate Readings in Modern Spanish.** Discussion, composition, listening practice. One course. *Miller and Staff*

**76. Introductory Spanish Conversation.** Practice in everyday conversational Spanish. Prerequisite: Spanish 63 or equivalent. Enrollment: maximum fifteen students. One course. *Garcí-Gómez and Staff*

**100. Active Spanish.** Conversation and written expression emphasizing oral communication. Prerequisite: Spanish 76 or consent of instructor. Limited to fifteen students. One course. *Garcí-Gómez or Staff*

**105. Spanish in Medicine and Nursing.** Introduction to medical language situations emphasizing oral communication. Prerequisite: Spanish 76 or consent of instructor. One course. *Garcí-Gómez*

**150T. Tutorial in Composition and Syntax.** Half-course. *Staff*

**153S, 154S. Spanish Language: Peninsular or American.** Topics to be announced. Two courses. *Staff*

**164. Topics of Spanish Civilization.** A humanistic study of Spain as a nation through its history, culture, people, and institutions. One course. *Garcí-Gómez*

**176S. Advanced Conversation.** This course is designed to develop facility of expression through constant drill on vocabulary and conversational idiom. Prerequisite: Spanish 100 or consent of instructor. One course. *Santí or Staff*

**177S. Advanced Composition.** Writing idiomatic Spanish: emphasis on topics in literature, law, business, and government. Prerequisite: Spanish 176 or consent of instructor. One course. *Santí or Garcí-Gómez*

**181. Intensive Spanish.** An introduction to language. Modern readings. Prerequisite: four semesters of another foreign language or consent of instructor. One course. *Miller*

**182. Readings in Spanish American Literature.** Prerequisite: Spanish 181 or consent of instructor. One course. *Miller*

**257. History of the Spanish Language.** Formation and development. Internal forces and external contributions. One course. *Garcí-Gómez*

**259. Spanish Phonetics.** A phonemic approach to the study of Spanish sounds.

Remedial pronunciation drills with special emphasis on rhythm and intonation. Readings in current studies of phonology. Prerequisite for undergraduates: Spanish 176 or consent of instructor. One course. *Predmore*

## Literature

**70, 71.** (These numbers represent one or two course credits for advanced placement in literature.)

**101, 102. Introduction to Literature and Civilization.** Literature, art, and history. First semester: Middle Ages through the eighteenth century. Second semester: nineteenth and twentieth centuries. Two courses. *Garci-Gómez or Staff*

**103S, 104S. Peninsular or Spanish-American Literature.** Topics to be announced. Open only to freshmen and sophomores. Two courses. *Staff*

**107, 108. Introduction to Spanish American Literature and Civilization.** A humanistic study of Spanish America through its literature, art, institutions, and film. Fall semester: the Colonial Period and first half of the nineteenth century. Second semester: second half of the nineteenth and twentieth century. Two courses. *Santí*

**117S. Spanish Traditional Poetry.** The Spanish *Romancero*; ballads and other forms of popular poetry. One course. *Garci-Gómez*

**141S, 142S. Spanish Literature.** Topics to be announced. Open to juniors and seniors. Two courses. *Staff*

**155. Spanish American Short Fiction.** Novelettes and short stories of the twentieth century. One course. *Fein*

**156. The Spanish American Novel.** Masterworks of the nineteenth and twentieth centuries. One course. *Fein*

**158. Spanish American Colonial and Nineteenth-Century Literature.** Chronicles of discovery and conquest, seventeenth-century prose, poetry, and drama. Romanticism and the Gaucho tradition. One course. *Santí*

**161. Spanish Literature of the Renaissance and the Baroque.** Selected works of the sixteenth and seventeenth centuries with attention to their reflection of social, religious, and political ideas. One course. *Miller or Wardropper*

**162. Spanish Romanticism.** A study of the romantic spirit in modern Spanish literature. One course. *Staff*

**163. The Generation of 1898.** Special emphasis on the novel and essay. The precursors: "Clarín" and Gánivet; Unamuno, Baroja, "Azorín," and Valle-Inclán; influence on the next generations; Pérez de Ayala and Ortega y Gasset. One course. *Predmore or Staff*

**165S. Major Spanish Authors.** Textual studies; methods of literary interpretation and criticism. One course. *Wardropper*

**166. Spanish Realism.** The growth of realism in Spanish literature of the nineteenth century. One course. *Staff*

**167. Golden Age Literature: Cervantes.** Emphasis on the *Quijote*. One course. *Predmore*

**169. Literature of Contemporary Spain.** Trends in the post-Civil War novel, theater, and poetry. One course. *Staff*

**170. The Picaresque Novel.** *Lazarillo*, selections from Alemán's *Guzmán de Alfarache*, Quevedo's *Buscón*, and Cervantes' *Novelas ejemplares*. Social and religious satire; comparative analysis of style; portrayal of the delinquent protagonist. One course. *Garci-Gómez*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified juniors by consent of instructor and Director of Undergraduate Studies. Two courses.

**193, 194. Independent Study.** Directed reading and research. Open only to qualified seniors by consent of instructor and Director of Undergraduate Studies. Two courses.

**251. The Origins of Spanish Prose Fiction.** Selected examples of the principal genres of the romance and the novel: *Amadís de Gaula*, Diego de San Pedro's *La cárcel de amor*, the *Abencerraje*, the *Lazarillo*, Montemayor's *Diana*. One course. *Wardropper*

**252S. Spanish Lyric Poetry Before 1700.** Selected poems of the Middle Ages, Renaissance, and Baroque. Special emphasis on the *Razón de amor*, *la poesía de tipo tradicional*, and *Santillana*; on Garcilaso, San Juan de la Cruz, Fray Luis de León, and Herrera; on Góngora and Quevedo. One course. *Wardropper*

**253. The Origins of Spanish Theatre.** Evolution of the Spanish theater from the *Auto de los Reyes Magos* (twelfth century) to the end of the sixteenth century. The idea of the theater as dramatic poetry will be stressed; close reading texts by Gómez Manrique, Encina, Gil Vicente, Torres Naharro, Lope de Rueda, Juan de la Cueva. One course. *Wardropper*

**255, 256. Modern and Contemporary Spanish American Literature.** First semester: poetry from *Modernismo* to the present. Second semester: twentieth-century fiction. Two courses. *Fein*

**257. History of the Spanish Language.** Formation and development of Spanish. Internal forces and external contributions. One course. *Garci-Gómez*

**258. Medieval Literature.** An introduction to selected authors and works. One course. *Garci-Gómez*

**260. Origins and Development of Spanish Romanticism.** Representative authors, including Espronceda, Rivas, Zorilla, Bécquer, and Rosalía de Castro, with a stress on drama and poetry. One course. *Staff*

**261. Nineteenth-Century Novel.** A study of literary trends in the last half of the nineteenth century. Readings will be selected from the novels of Valera, Pereda, Galdós, Pardo Bazán, Blasco Ibanez, and their contemporaries. One course. *Staff*

**262. Galdós.** Works selected from the *Novelas contemporáneas*, the *Episodios nacionales*, and his drama. One course. *Staff*

**265. Cervantes.** The life and thought of Cervantes with special emphasis on his *Quixote*. One course. *Predmore or Wardropper*

**266. Drama of the Golden Age.** The chief Spanish dramatists of the seventeenth century with readings of representative plays of this period. One course. *Wardropper*

**275, 276. Contemporary Spanish Literature.** First semester: the essay and lyric poetry. Revision of national values and literary expression in the twentieth cen-



tury, with particular reference to the crisis of 1898 and to the enrichment of the Spanish tradition through extra-peninsular influences. Second semester: tradition and innovation in the twentieth-century Spanish novel with emphasis on the novels of Unamuno, Baroja, Valle Inclán, and Pérez de Ayala. Two courses. *Predmore*

## ROMANCE LANGUAGES

### Literature in English Translation

**124. Continental Humanism.** Readings from Boccaccio, Petrarch, Rabelais, Montaigne, Rojas, Cervantes, and Erasmus. One course. *Tetel*

**160. An Approach to Comedy.** Nature, purpose, and effect of comedy in the theater. Readings from the classics (Aristophanes, Plautus, Terence), the Renaissance (Machiavelli, Shakespeare, Molière, Lope de Vega), the Restoration and the twentieth century. One course. *Wardropper*

### Language

**218. The Teaching of Romance Languages.** Evaluation of objectives and methods; practical problems involved in teaching these languages on the elementary, secondary, and college level; analysis of textbooks, special foreign language programs, audiovisual aids, and tests. One course. *Hull*

## DEPARTMENTAL MAJOR

*Prerequisite.* French or Spanish 74 or proficiency.

*Major Requirements.* Literature Major: a total of eight courses (above 76), no fewer than five literature courses, and no fewer than two language courses. The literature courses must represent at least three of the six historical periods (medieval, Renaissance, seventeenth, eighteenth, nineteenth, twentieth, and Spanish-American for Spanish).

*Language Major.* A total of eight courses, no fewer than four language courses. (For French, from 100, 126, 127, 128, 129, 130, 150T, 210, 224; for Spanish, from 100 or 105, 150T, 153S, 154S, 176S, 177, 257, 259) and no fewer than two literature courses.

*Study Abroad.* No more than two courses per semester and one course per summer count toward the major.

In order to give perspective to a student's program, majors in Romance languages will normally select, with the approval of the major adviser, appropriate courses from such fields as: (1) other languages and literatures; (2) history; (3) philosophy; (4) appreciation courses in music and art; and (5) linguistics.

## Slavic Languages and Literatures

Professor Krynski, *Chairman*; Associate Professor Jezierski, *Director of Undergraduate Studies and Supervisor of Language Instruction*; Assistant Professor Shonek; Lecturer Sagatov

**1, 2. Elementary Russian.** Introduction to understanding, speaking, reading, and writing. Audiolingual techniques are combined with required recording-listening practice in the language laboratory. Two courses. *Staff*

**63, 64. Intermediate Russian.** Intensive classroom and laboratory practice in

spoken and written patterns. Reading in contemporary literature. Prerequisite: Russian 1, 2, or two years of high school Russian. Two courses. *Staff*

**101, 102. Russian Literature and Culture Through the Nineteenth Century.** Prose, poetry, and drama with special attention to later periods. Readings in English (from *The Igor Tale* to *Blok*). Two courses. *Jezierski*

**105. The Russian Theatre and Drama.** Russian drama from its beginnings to the present. Readings in English or Russian. One course. *Jezierski*

**119. Introduction to Russian Literature of the Nineteenth Century.** Conducted in Russian. Prerequisite: Russian 63, 64 or equivalent. One course. *Sagatov*

**120. Introduction to Russian Literature of the Twentieth Century.** Conducted in Russian. Prerequisite: Russian 119. One course. *Sagatov*

**119P, 120P. Preceptorial.** Elective preceptorials for students enrolled in Russian 119, 120. *Sagatov*

**124. Masters of Russian Short Fiction.** Pushkin, Gogol, Turgenev, Tolstoy, Dostoevsky, Chekhov, Babel, and others. Readings in English. One course. *Jezierski*

**161. Introduction to the Russian Novel.** Outstanding works of Lermontov, Gogol, Turgenev, Goncharov, Tolstoy. Readings in English. One course. *Krynski*

**162. Introduction to the Russian Novel.** Outstanding works of Dostoevsky, Bely, Solugub, Bunin, Gorky. Readings in English. One course. *Krynski*

**174. The Poles: Literature and Culture, 1940-1970.** Culture of Poland; representative literary masterpieces. Emphasis on Western literary avant-garde and Soviet political influences; Jewish themes. Readings in English. One course. *Krynski*

**174P. Preceptorial.** Elective preceptorial for students enrolled in Slavic Language and Literatures 174. *Krynski*

**175S. Leo Tolstoy.** Introduction to life and works. Readings in English will include *War and Peace*, *Anna Karenina*, the shorter fiction, dramatic works, and essays. Tolstoy's impact on the literature and thought of today, in and outside of Russia. One course. *Jezierski*

**176. Fyodor Dostoevsky.** Introduction to life and works. Emphasis on his relevance to today's world. Readings in English of major works; close study of *Crime and Punishment*, *The Idiot*, and *The Brothers Karamazov*. Historical overview of critical reaction in Russia and abroad. One course. *Jezierski*

**177. Introduction to the World of Chekhov.** Close scrutiny of selected prose and dramatic works of a Russian precursor of the modern sensibility. Readings in English. One course. *Jezierski*

**177P. Preceptorial.** Elective preceptorial for students enrolled in Slavic Languages and Literature 177. *Jezierski*

**183. Slavic Drama and Theatre of the Twentieth Century.** Russian, Polish, and Czech plays from the beginning of the century through the mid-seventies: Chekhov, Mayakovsky, Evreinov, Witkiewicz, Gombrowicz, Mrozek, Rozewicz, and Capek. Theatrical theories of Meyerhold, Vakhtangov, Tairov, Grotowski, and others. Slavic avant-garde developments, especially of the last two decades, in the context of Western European "theatre of the absurd." Readings in English, or, if qualified, in Russian or Polish. One course. *Krynski*

**184. The Jews in Russian and Polish Literature Since 1917.** Jewish themes and protagonists in the works of leading writers of Russia and Poland, both Jewish and non-Jewish. Historical background of Jews and their role in the early stages of the Revolution and the dissident movement after Stalin's death. Readings in English, or if qualified, in Russian or Polish. One course. *Krynski*

**185. Vladimir Nabokov.** The Russian and English novels, short fiction, plays, poetry, and criticism of Vladimir Nabokov. Readings in English. Qualified students may do some readings in Russian. One course. *Jezierski*

**188. Solzhenitsyn and the World of Soviet Concentration Camps.** The major works of Alexander Solzhenitsyn with emphasis on concentration camp writings. Background readings by other authors and scholars, Russian and Western. One course. *Krynski*

**190. Russian Nobel Prize Winners.** The fiction of Bunin, Sholokhov, Pasternak, and Solzhenitsyn. Readings in English, or, if qualified, in Russian. One course. *Krynski*

**191, 192. Independent Study.** Directed reading and research. Open only to qualified students by consent of Director of Undergraduate Studies. Two courses. *Staff*

**193, 194. Independent Study.** Directed reading and research for qualified seniors. Prerequisite: consent of Director of Undergraduate Studies. Two courses. *Staff*

**195. Advanced Russian.** Review of grammar with an emphasis on the refinement of oral and written language skills. Prerequisite: Russian 120 or consent of instructor. One course. *Sagatov*

**196. Readings in Modern Russian.** An intensive reading-conversation course based on contemporary Russian literary and Soviet press texts, emphasizing problems in Russian-English and English-Russian translation. Prerequisite: Russian 195 or consent of instructor. One course. *Sagatov*

#### **For Seniors and Graduates**

**201, 202. Russian Novel of the Nineteenth Century.** First semester: 1830-1870. Second semester: 1870-1900. Prerequisite 161, 162 or equivalent. Two courses. *Krynski*

**205. The Structure of Polish in Relation to Russian.** Comparative and contrastive study of the two major Slavic languages. Emphasis on preparing students to read Polish literary texts. One course. *Krynski*

**206. Readings in Contemporary Polish Prose in the Original.** Stylistic analysis of aphoristic prose by Stanislaw Lec, philosophical allegories by Leszek Kolakowski, and short stories by Slawomir Mrozek and Marek Hlasko. One course. *Krynski*

**207. Soviet Literature and Culture.** Literature since 1917. Readings in English from major works of prose, poetry, and drama. One course. *Jezierski*

**207P. Preceptorial.** Elective preceptorial for students enrolled in Slavic Languages and Literatures 207. *Jezierski*

**212. Pushkin.** Survey of life and works, his role as precursor of modern Russian literature. Readings in English and Russian. Prerequisite: Russian 101 or consent of instructor. One course. *Krynski*

**225S. Tolstoy.** *War and Peace* and other works. Prerequisite: Russian 175S or equivalent. One course. *Jezierski*

227S. **Gogol.** Life and works: short stories, dramas, and the novel. Readings in English or Russian. One course. *Jezierski*

232. **Dostoevsky.** Emphasis on *Brothers Karamazov* and the theory of the novel. Prerequisite: Russian 176 or equivalent. One course. *Jezierski*

## DEPARTMENTAL MAJOR

*Prerequisites.* Russian 1, 2 and 63-64, or equivalent.

*Major Requirements.* A minimum of eight courses in the department. All majors must take the following courses: Russian 119, 120, 195, 196, plus four courses in literature.

Students contemplating graduate work may elect a more intensive program consisting of ten courses. A knowledge in depth of Russian literature or some knowledge of Polish language and/or literature will facilitate admission to graduate school and subsequent study in the field.

## Sociology

Professor Back, *Chairman*; Associate Professor Simpson, *Director of Undergraduate Studies*; Professors Back, Kerckhoff, Maddox, McKinney, Myers, Palmore, Portes, Preiss, Roy, Smith, and Tiryakian; Associate Professors House and Wilson; Assistant Professors Campbell, Evers, Hirschman, McGee, and Rice

Understanding the nature of social relationships, groups, and organizations is essential to humane and rational action in an increasingly complex world. The Department of Sociology attempts to impart such understanding as one element of a liberal education. Undergraduate work in sociology, as in the other arts and sciences, does not prepare students for a specific vocation, but it is useful and adequate preparation for either employment or graduate study in any of the following areas: sociology and other social sciences, business, government and public service, and the professions of education, law, medicine, or social work.

The department and its offerings represent the diversity of topics and approaches in sociology, while also offering more concentrated work in certain areas, including deviant behavior (courses 120-123), population and ecology (141, 145, 243), family, sex roles, and socialization (149, 150, 152, 272, and 278), and others. In the major and in many courses, emphasis is placed on learning how to do sociology as well as on studying what others have done. Active involvement in the learning process is also fostered through seminar courses, independent study, honors work and internship, or fieldwork experiences. The Department offers both internship courses and encourages students to arrange individual internship experiences for which they receive independent study credit if the internship is coordinated with related academic study.

To provide a variety of educational experiences for the beginning student of sociology, the introductory course, Introduction to Sociology, has a variety of structures. In each, however, students learn basic approaches of sociology to social reality and some of the problems involved in observing, describing, and analyzing facets of social life.

**91. Introduction to Sociology.** Sections of limited enrollment (about thirty-five to fifty). One course. *Staff*

**91D. Introduction to Sociology.** Two lectures and one discussion section (no more than twenty students per section). One course. *Staff*

**91S. Introduction to Sociology.** Taught as a seminar, enrollment limited to twenty per class. One course. *Staff*



**101. Contemporary American Society.** Social trends and social problems and their effects on individuals and society. Urbanization; bureaucracy; distribution of wealth, income, and power; status of minorities. One course. *House or McGee*

Sociology 120-122 are designed as a sequence, and might optimally be taken in that order, with Sociology 120 being recommended preparation for 121, 122, and 123. However, there are no required prerequisites.

**120. Perspectives on Deviant Behavior.** Development and distribution of deviant social behavior, treating such topics as social disorganization, stress and strain, cultural and labeling theories in relation to crime and delinquency, drug addiction, homosexuality, suicide, or others. (Not open to students who have taken Sociology 143.) One course. *Preiss or Rice*

**121. Law Enforcement and Judicial Systems.** Treatment of deviant behavior by police, prosecutors, and courts. Problems of justice, efficiency, and ethics. Cross-cultural comparisons. One course. *Preiss or Rice*

**122. Punishment and Treatment of Deviants.** Concepts of punishment and rehabilitation. Programs and facilities for deviants. Structure and operation of "total" institutions, such as prisons and hospitals. Problems of returning to family and community life. One course. *Preiss or Rice*

**123. Social Aspects of Mental Illness.** Theoretical and practical sociological contributions to problems of etiology, definition, law and treatment; comparisons with other contributions; questions of public policy and programs. One course. *Back, McGee, or Preiss*

**132. Introduction to Sociological Research.** Observation, measurement, analysis, and methods of presenting research findings. One course. *Evers, Hirschman, or Rice*

**136. Sociology of Modern Africa.** An introduction to the modernization of sub-Saharan Africa. Primary emphasis given to the nature and formation of colonial society, as well as to the process of decolonization and its sources. One course. *Tiryakian*

**141. Population and Ecology.** Relation of fertility, mortality, and migration to social development, population composition, and distribution. One course. *Evers, Hirschman, or Myers*

**142. The Sociology of Mass Communication.** An analysis of the role of radio, the press, magazines, movies, and television in modern societies. An examination of the selective audiences, content characteristics, controlling elements, and organizational structure of the various media of mass communication. Comparative Canadian material considered where feasible. One course. *Smith*

**144. Political Sociology.** Politics as social behavior involving change in institutions and structures; current national and local issues. One course. *House, Portes, or Preiss*

**145. Urban Sociology.** Historical, demographic, and ecological materials are used to study urban society with respect to its institutions, interaction patterns, differentiation, integration, disorganization, and decentralization. Comparative Canadian material considered where feasible. One course. *Myers, Portes, or Smith*

**146. Industry and Society.** A study of the community and organizational life of industrial and white-collar workers in relation to the changing institutions of modern society. One course. *Roy*

**147. The Black in the City.** A comparative analysis of the situations and expe-

periences of Black people in urban settings with attention to class, caste, ethnic, social, and racial factors. (Also listed as Black Studies 147.) One course. *Staff*

**149. Sex Roles and Society.** Nature and acquisition of sex roles. Cross cultural variations. Developing nature of sex roles in American society. One course. *McGee*

**150. The American Family.** The American family as an institutionalized group and its relationship with other institutions; the social psychology of family relations; variations by social class and ethnic group. One course. *Kerckhoff, McGee, Roy, or Simpson*

**151. Sociology of Religion.** The religious factor in modern society and the social factor in modern religion. Major sociological theories and marginal religious groupings. One course. *Tiryakian or Wilson*

**152. Sociology of Education.** Structure and operation of formal educational institutions in Western society and their effects on the social structure. Equality of opportunity, family-school, community-school, student-school relations, and peer influences in the school. One course. *Campbell, Kerckhoff, or Roy*

**154. The Sociology of the Arts.** An analysis of the social relations of the world of the arts (painting and sculpture, music, and literature) with emphasis upon creative artists, art publics, art organizations, and art works as they function in their social-cultural milieux. One course. *Back or Tiryakian*

**155. Sociology of Work.** Study of social organizations of work activities, of the human experiences and group relationships involved. Special focus on management-employee conflict and cooperation. One course. *Roy*

**156. The Changing Roles of Men and Women: History and Prospects.** (Also listed as Interdisciplinary Course 156.) Half-course. *O'Barr, McElroy, and McGee*

**157. Inequality in America.** Differences in social position in the United States as they relate to income, prestige, and power. Primary focus on the process of achievement, including level of education and occupational position, while controlling for race, sex, and age. One course. *Evers or Kerckhoff*

**159. Black and White Relations in America.** The history and changing nature of interaction between Blacks and Whites, including the sources and consequences of discrimination, integration, and Black power. One course. *Staff*

**160. Minorities and Work.** Work and careers of minorities in relation to structures that limit their free movement in the labor force. One course. *Simpson*

**172. Collective Behavior.** Rumor and contagion as general processes; collective expression such as riots, protests, and behavior in disaster. Focus on contemporary Western society. One course. *Portes or Kerckhoff*

**173. Social Movements.** Social movements as agents of change. Structure and development of protest groups. One course. *Wilson*

**184. Canada: Problems and Issues of an Advanced Industrial Society.** (Also listed as Interdisciplinary Course 184.) *Preston and Visiting Lecturers*

**193, 194. Independent Study.** Prerequisite: consent of instructor. Two courses. *Staff*

**195S, 196S, 197S, 198S. Seminar in Special Topics.** Four courses. *Staff*

## For Seniors and Graduates

**201. Social Change.** Causes, indicators, and consequences. Classical and contemporary theorists Marx, Weber, Sorokin, Parsons, Lenski, and others. One course. *Staff*

**202. Social Organization.** Contrasting conceptions with emphasis on the sustenance and evolution of social arrangements. One course. *Staff*

**225. Medical Sociology.** Current issues in the organization, development and the utilization of resources for health care. One course. *Back or Maddox*

**230. Social Aspects of Aging and Death.** Theories of human aging; social problems caused by increased longevity, discrimination against the aged, retirement, widowhood, and other role losses. Social-psychological factors in mortality, accidental death, suicide, and murder. One course. *Palmore*

**241. Social Stratification.** The nature of hierarchical and vertical differentiation for the economic, political, and prestige structures in modern societies. The interrelationship of class, status, and power strata and their influence on social institutions, personality structure, and group and individual behavior. The transmission of inequality from one generation to the next. One course. *Campbell, Evers, or Roy*

**242. The Sociology of Occupations and Professions.** The social significance of work. Analysis of forces changing the contemporary occupational structure, typical career patterns of professions and occupations, and social organization of occupational groups. One course. *Roy or Simpson*

**243. Population Dynamics and Social Change.** Social scientific aspects of the determinants and consequences of population trends. One course. *Evers, Hirschman, or Myers*

**244. Human Ecology and Urban Systems.** Origins and development of human ecology theory, growth of cities and urban systems, residential segregation of social classes and racial and ethnic groups. One course. *Evers, Hirschman, Myers, or Smith*

**246. Population Policy.** Formation, effect, and evaluation. Historical examples of mortality, fertility, migration, and distribution policies. The Malthusian and neo-Malthusian controversies. Psychological, sociological, demographic, and political background. (Also listed as Public Policy Studies 246.) One course. *Back*

**251. The Sociology of Modernization.** Theories and perspectives on the nature of modernization and modernity in Western and non-Western countries. One course. *Hirschman, Portes, or Tiryakian*

**254. Urbanization and Social Change.** Interactions between social structure and physical space in three contexts: (a) the re-emergence of cities in Medieval Europe; (b) the contemporary evolution of cities and their hinterlands in the United States; and (c) patterns of urbanization in the Third World. One course. *Portes*

**259. Religion and Social Change.** The role of religion in significant social changes in Western and non-Western societies; noninstitutional phenomena (charisma, prophecy, messianism, revivals, glossolalia). One course. *Tiryakian or Wilson*

**260. Science, Technology, and Society.** Science as a social phenomenon. Relations of science to technology and their articulation through public policy. Interaction of the institutions of science with other societal institutions. One course. (Also listed as Psychology 260.) *Bevan and McKinney*

**261. Science, Politics, and Government.** The structure and values of the scientific community, the mechanism and strategies of government, and their mutual interdependence in American society. (Also listed as Public Policy Sciences 255 and Psychology 261.) One course. *Bevan and McKinney*

**272. The Socialization Process.** Mechanisms and variations in socialization by position in the social structure (class, race, urban-rural); contributions made by various socialization agencies (family, school, peer groups, mass media) in Western society. One course. *Kerckhoff and McGee*

**275. Social Structure and Personality.** Processes by which social structures and social change (including class, modernization, societal and organizational membership) affect individual attitudes and behaviors. Nature and effect of stress, alienation, and other forms of incongruence between individuals and social structures. One course. *House or Portes*

**276. Small Groups and Social Life.** A systems theoretical approach. Basic group processes including communication, integration, sub-group formation, specialization, hierarchy, and leadership; different types, contexts and interrelations of groups. One course. *Back*

**278. Social Structure and the Life Cycle.** Relationship between age as a social characteristic and social interaction, with particular reference to adolescence and old age. One course. *Maddox*

**281. Seminar in Sociological Theory.** Development, convergence, and utilization of sociological theories. One course. *Tiryakian or Wilson*

**291. Research Methods and Techniques I.** Principles and methods of collecting and utilizing questionnaire and survey data. Applications of methods, secondary analysis, laboratory and field experimentation, observation and other types of research. Prerequisite: Sociology 132 or 293 or equivalent. One course. *Evers, House, Portes, or Smith*

**292. Research Methods and Techniques II.** Principles, methods, and applications of depth interviewing, participant observation, content and analysis, unobtrusive measures, historical and archival analysis. Issues of reliability, validity, quantification, multiple methodologies, and the interrelationship of theory and method. One course. *McGee or Roy*

**293. Introductory Statistical Analysis.** Basic descriptive statistics, regression and correlation, t-tests and the analysis of variance, chi square techniques, and other topics. Stress on practical applications. Statistical computing using SPSS and other programs. One course. *Campbell*

**294. Intermediate Statistical Analysis.** The general linear model and its application in methods of multivariate statistical analysis: analysis of variance and covariance, multiple regression and path analysis, and log-linear models for categorical data. Statistical computing using SPSS and other programs. Prerequisite: Sociology 293 or equivalent. One course. *Campbell or Rice*

**295. Methodology in Sociology.** The nature of scientific method, as well as alternative paths to knowledge, as they apply to sociology. Conceptualization, hypothesis formation, and definition. The research process as a decision-making situation for both general research design and specific techniques. The process and logic of data analysis. Relations of theory and research are stressed. One course. *Back or Smith*



**298S, 299S. Seminar in Selected Topics.** Substantive, theoretical, or methodological topics. Two courses. *Staff*

## DEPARTMENTAL MAJOR

*Prerequisite.* Sociology 91.

*Major Requirements.* Seven courses in the department above 91, including Sociology 132 and either one 200-level course or one senior seminar.

A sociology major normally takes at least four related courses in the following departments: Anthropology, Economics, Education, History, Mathematics, Political Science, or Psychology.

*Honors.* Qualified majors are encouraged to undertake work leading to graduation with distinction. A major with a *B+* average in sociology and a *B* average in all courses is eligible, though the Director of Undergraduate Studies may waive this requirement in special cases. To receive departmental honors a major must complete a paper involving significant independent research or scholarship and pass an oral examination on the paper conducted by a three-person committee, at least two of whom, including the chairman, must be members of the department. Normally, students will prepare the paper over the course of the senior year, working in close collaboration with their chairman and committee, and receiving on the average two course credits in independent study.

## Statistics

Statistics courses offered in several departments at Duke are classified according to function (Tracks) and level as follows: Track 1 includes statistical inference courses for nonstatisticians; Track 2, statistical inference courses for statisticians; Track 3, stochastic processes courses; and Track 4, stochastic communications theory courses. Within each track, courses are classified by level according to the amount of prerequisite statistical knowledge needed. First-level Track 1 courses, which are basic statistics courses for nonstatisticians, cover a certain core curriculum and have no formal statistical prerequisites. For further information on the statistics courses see *Statistics at Duke*, which is available on request from the Department of Mathematics.

## University Courses

University courses are offered by distinguished professors. They are electives for juniors and seniors in a form free from ordinary class restrictions.

**199S.1. Current Political Problems in Western European and Commonwealth Countries.** One course. *Cole*

**199S.2 Death and Dying.** One course. *Cleland*

## Zoology

Professor Fluke, *Chairman*; Associate Professor Ward, *Director of Undergraduate Studies*; Professors Bailey, Barber, Costlow, Gillham, Gregg, Klopfer, Livingstone, Nicklas, Schmidt-Nielsen, Tucker, Wainwright, and K. Wilbur; Associate Professors Lundberg, Sutherland, and Vogel; Adjunct Professor Schmidt-Koenig; Assistant Professors Delson, Forward, McClay, Nijhout, Storey, and H. Wilbur; Instructor Rickoll

See *Biology* for listing of introductory courses.

The *L* suffix on a zoology course number indicates that the course includes a laboratory.

In addition to those courses bearing the *S* suffix, the following zoology courses also fulfill the seminar-type learning experience: 120L, 173L, 180L, 204L, 216L, 218L, 222L, 224L, 238L, 258L, 262L.

**103L. Principles of Ecology.** Physical, chemical, and biological processes that determine the distribution and abundance of animals, emphasizing population dynamics, species interaction, biogeography, nutrient cycling, and energy flow through food webs. Prerequisites: introductory biology and Mathematics 31. Lectures, field and laboratory exercises, and student talks. One course. *H. Wilbur and Livingstone*

**108L. Developmental and Comparative Anatomy of Vertebrates.** Lectures and laboratory on the embryology, anatomy, and evolution of vertebrate organ systems. Prerequisite: introductory biology. One course. *Lundberg*

**114L. Introduction to Biological Oceanography.** Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Not open to students who have had Geology 53 or Botany 53. Prerequisite: introductory biology. (Given at Beaufort.) One and one-half courses. *Rowe (Visiting Summer Faculty)*

**117. Genetics and Society.** An introduction to genetics with emphasis on the effects of environment and heredity upon the individual and the population. Students may not receive credit for both Zoology 117 and 180 or Nursing 105. Prerequisite: introductory biology or consent of instructor. One course. *Ward*

**120L. Ornithology.** Lectures, laboratory, and field trips dealing with the classification, adaptations, and natural history of birds. Prerequisite: introductory biology. Zoology 108 is recommended. One course. *Bailey*

**135. Evolutionary Systematics.** Evolutionary mechanisms in speciation and phylogeny in plants and animals: geographic and reproductive isolation, breeding systems, hybridization, homology, convergence, and extinction. Assessment of modern techniques (cytotaxonomy, chemotaxonomy, numerical taxonomy) in classification. Complements Botany 186, Botany 286, Zoology 186, and Zoology 286. Lectures. Prerequisite: introductory biology. (Also listed as Botany 135, Botany 235, and Zoology 235.) One course. *Bailey, Lundberg, and Stone (Botany)*

**135L. Evolutionary Systematics.** See Zoology 135. Lectures and laboratories. One course. *Bailey, Lundberg, and Stone (Botany)*

**150L. Physiology of Marine Animals.** Comparative physiology including ecological and behavioral adaptations. Students may not receive credit for both Zoology 150L and 250L. Prerequisites: introductory biology and Chemistry 12. (Given at Beaufort.) One course. *Forward*

**151L. Principles of Physiology.** An introductory survey. Prerequisites: introductory biology and Chemistry 12. One course. *Tucker (fall), Storey (spring)*

**160. Principles of Cell Biology.** Structure and function of organelles, metabolism, and regulatory mechanisms. Lectures. Prerequisites: introductory biology and Chemistry 12. One course. *McClay*

**160L. Principles of Cell Biology.** See Zoology 160. Lectures and laboratories. One course. *McClay and Staff*

**169L. The Marine Environment.** (For description, see Marine Sciences.) One course. *Sutherland*

**173L. Tutorial in Animal Diversity.** Comparative functional morphology of animals of major phyla. Lectures, laboratories, and tutorials (essays and oral reports). Not open to students who have had Zoology 174, 175, or 275. Prerequisite: introductory biology and consent of instructor. One course. *Wainwright*

**174L. Animal Diversity.** See Zoology 173L. Not open to students who have had Zoology 173, 175, or 275. Lectures and laboratories. Prerequisite: introductory biology. One course. *Wainwright*

**175L. Invertebrate Zoology.** Emphasis on development and physiology. Lectures, laboratories, and field trips. Not open to students who have had Zoology 173, 174, or 274. Prerequisite: introductory biology. One course. *Nijhout (Durham) or Staff (Beaufort)*

**180. Principles of Genetics.** Structure and properties of genes and chromosomes, and evolution of genetic systems. Lectures. Prerequisites: introductory biology, Chemistry 12, and Mathematics 31, or their equivalents. (Also listed as Botany 180, Botany 280, and Zoology 280, and under the University Program in Genetics.) One course. *Antonovics (Botany), Boynton (Botany), and Gillham*

**180L. Principles of Genetics.** See Zoology 180. Lectures and laboratories. One course. *Antonovics (Botany), Boynton (Botany), Gillham, and Ward*

**186. Evolutionary Mechanisms.** Evolutionary mechanisms in population ecology and population genetics of plants and animals: natural selection, adaptation, species interactions, mating systems, fitness concepts, and genetic divergence. Complements Botany 135, Botany 235, Zoology 135, and Zoology 235. Prerequisite: introductory biology. (Also listed as Botany 186, Botany 286, Zoology 286, and under the University Program in Genetics.) One course. *Antonovics (Botany), and H. Wilbur*

**191, 192. Independent Study.** For junior and senior majors with consent of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credit to be arranged. *Staff*

**193T, 194T. Tutorial.** For junior and senior majors with consent of the Director of Undergraduate Studies and the supervising instructor. Three courses of 191, 192, 193T, and 194T maximum. Credit to be arranged. *Staff*

**197, 198. Undergraduate Colloquium.** Does not satisfy major or distributional requirements. One course maximum except with consent of Director of Undergraduate Studies. *Staff*

## For Seniors and Graduates

The *L* suffix on a Zoology course number indicates that the course includes a laboratory.

**201L. Animal Behavior.** Emphasis on recent physiological and developmental studies. Prerequisites: physiology, genetics, and evolution, or consent of instructor. One course. *Klopfer*

**202L. Introduction to Comparative Behavior.** Behavior as revealed by physiological, evolutionary, and ecological studies with primary emphasis on marine groups. Prerequisite: one course in physiology. (Given at Beaufort.) One and one-half courses. *Staff*

**203L. Marine Ecology.** Application of ecological theory to marine systems. Mathematical properties of population growth and species interactions; field and laboratory projects with computer-assisted analysis of data. Practice in scientific writing. Readings from current scientific publications. Prerequisites: introductory biology or invertebrate zoology and calculus. Knowledge of statistics helpful. (Given at Beaufort.) One and one-half courses. *Sutherland*

**204L. Population and Community Ecology.** Theoretical ecology emphasizing the evolution of life cycles, mathematical properties of systems of interacting species, and mechanisms of species interactions. Laboratories emphasize biometrical and experimental testing of ecological theory in relation to a variety of habitats. Individual projects and weekend field trips. Prerequisites: Zoology 103, calculus, senior or graduate standing, or consent of instructor. One course. *H. Wilbur*

**205. Elements of Theoretical Biology.** An introduction to elementary mathematical biology, conceived as the study of axiomatized mathematical theories and their biological models. Prerequisites: introductory biology and mathematics, or consent of instructor. One course. *Gregg*

**211. Mathematical Models in Biology.** Adaptation of physical laws to the description of biological phenomena. Prerequisites: one year of college mathematics and one course in statistics or consent of instructor. (Given at Beaufort.) One and one-half courses. *Monroe (Visiting Summer Faculty)*

**214L. Biological Oceanography.** Impact of biological processes on the physical and chemical character of the environment and the regulating role of abiotic processes on organic productivity. Factors regulating primary and secondary productivity with the estuary and ocean as examples. Emphasis on design and execution of directed research. Prerequisite: consent of instructor, introductory biological or chemical oceanography recommended. (Given at Beaufort.) One and one-half courses. *Barber*

**216L. Limnology.** Lakes, ponds, and streams; their origin, development, geochemistry, energy balance, productivity, and the dynamics of plant and animal communities. Lectures, field trips, and laboratories. Offered in alternate years. Prerequisites: introductory biology, Chemistry 12, physics, and Mathematics 31, or consent of instructor. One course. *Livingstone*

**218L. Paleobiology.** The dynamics of past ecosystems; climatology and ecological geography of the past few million years; laboratory study of lake-bed deposits with emphasis on Quaternary pollen grains. Prerequisites: consent of instructor and a course in ecology. One course. *Livingstone*

**222L. Entomology.** The biology of terrestrial arthropods. Lectures, laboratories, and field trips. Prerequisite: introductory biology. One course. *Nijhout*

**224L. Vertebrate Natural History.** Life histories, adaptations, ecology, and classification of vertebrate animals. Prerequisite: Zoology 108. One course. *Bailey*

**229. Morphogenetic Systems.** Lectures on the interplay of theory and experiment in twentieth-century developmental biology. Prerequisite: introductory biology. One course. *Gregg*

**235. Evolutionary Systematics.** Evolutionary mechanisms in speciation and phylogeny in plants and animals: geographic and reproductive isolation, breeding systems, hybridization, homology, convergence, and extinction. Assessment of modern techniques (cytotaxonomy, chemotaxonomy, numerical taxonomy) in classification. Complements Botany 186, Botany 286, Zoology 186, and Zoology 286.



Lectures. Prerequisite: introductory biology. (Also listed as Botany 135, Botany 235, and Zoology 135.) One course. *Bailey, Lundberg, and Stone (Botany)*

**235L. Evolutionary Systematics.** See Zoology 235. Lectures and laboratories. One course. *Bailey, Lundberg, and Stone (Botany)*

**238L. Systematic Zoology.** Theory and practice of collection, identification, and classification of animals. Prerequisite: introductory biology. One course. *Bailey*

**239S. Biogeography.** Old and new distributional concepts of animals and plants involving physical geography, geology, paleontology, systematics, evolution, population dynamics, and dispersal. Prerequisite: consent of instructor. One course. *Bailey*

**245. Radiation Biology.** Actions of ionizing and excitational radiations on life processes; biological use of radioactive tracers; nucleonics. Prerequisites: physics, Mathematics 32, and Chemistry 12. One course. *Fluke*

**246. Physical Biology.** Biomechanics, physical optics, and other physical topics applied to living organisms and systems at various levels of organization. Prerequisites: Mathematics 32, Chemistry 12, physics, and one biology course beyond the introductory level, or consent of instructor. One course. *Fluke and Wainwright*

**250L. Physiological Ecology of Marine Animals.** The physiology of marine animals as related to environmental factors of salinity, temperature, oxygen, and light. Prerequisite: a course in physiology. (Given at Beaufort.) One and one-half courses. *Forward*

**252. Comparative Physiology.** The physiological mechanisms of animals studied on a comparative basis. Prerequisite: Zoology 151 or equivalent. One course. *Schmidt-Nielsen*

**254S. Fluid Flow and Living Systems.** Physical principles of low speed flow; applications to locomotion, circulation, dispersal, ventilation, filtration, and heat dissipation. Prerequisites: physics and Mathematics 31, or their equivalents. One course. *Vogel*

**258L. Laboratory Research Methods.** Radioisotope methods, spectrophotometry, light microscopy, transmission and scanning electron microscopy, X-ray diffraction, gel electrophoresis, isolation of cell components, and other methods. Students may select methods according to their interests and research needs. Prerequisite: consent of instructor. Credits to be arranged. *K. Wilbur and Staff*

**260. Advanced Cell Biology.** Structural and functional organization of cells and their components, emphasizing current research problems and prospects. Prerequisites: introductory cell biology (or genetics and consent of instructor); introductory biochemistry recommended (may be taken concurrently). One course. *Nicklas, K. Wilbur, and Staff*

**262L. Cytological Materials and Methods.** Cytological analysis, with emphasis on chromosome studies using advanced optical, cytochemical, and experimental techniques. Offered in alternate years. Prerequisite: Zoology 260 or equivalent (may be taken concurrently). One course. *Nicklas*

**265S, 266S. Seminar in Chromosome Biology.** Current research in chromosome structure and function, mitosis, and meiosis. Prerequisites: a course in cell biology or genetics and consent of instructor. (Also listed as Anatomy 265, 266.) Two half-courses. *Moses (Anatomy) and Nicklas*

**274L. Marine Invertebrate Zoology.** Structures, functions, and habits of invertebrate animals under natural and experimental conditions. Field trips included. Not open to undergraduate students who have had Zoology 175 except with consent of Director of Undergraduate Studies. Prerequisite: introductory biology. (Given at Beaufort.) One and one-half courses. *Barnes (Visiting Summer Faculty)*

**278L. Invertebrate Embryology.** Lectures, readings, and laboratory work dealing with rearing, development, and life histories of invertebrates. Prerequisites: consent of instructor. (Given at Beaufort.) One and one-half courses. *McClay*

**280. Principles of Genetics.** Structure and properties of genes and chromosomes and evolution of genetic systems. Prerequisites: introductory biology, Chemistry 12, and Mathematics 31, or their equivalents. (Also listed as Botany 180, Botany 280, Zoology 180, and under the University Program in Genetics.) One course. *Antonovics (Botany), Boynton (Botany), and Gillham*

**286. Evolutionary Mechanisms.** Evolutionary mechanisms in population ecology and population genetics of plants and animals: natural selection, adaptation, species interactions, mating systems, fitness concepts, and genetic divergence. Complements Botany 135, Botany 235, Zoology 135, and Zoology 235. Prerequisite: introductory biology. (Also listed as Botany 186, Botany 286, Zoology 186, and under the University Program in Genetics.) One course. *Antonovics (Botany) and H. Wilbur*

**288S. The Cell in Development and Heredity.** A seminar on topics of current interest and controversy. Prerequisites: a course in genetics and consent of instructor. (Also listed as Anatomy 288.) Half-course. *Counce (Anatomy)*

**295S, 296S. Seminar.** Topics, instructors, and course credits announced each semester. *Staff*

**Genetics, The University Program.** Genetics courses offered by the Department of Zoology are part of the University Program in Genetics described in this *Bulletin*.

**Marine Laboratory.** Consult Marine Sciences in this *Bulletin* for offerings at the Duke University Marine Laboratory and for details of the spring semester program for undergraduates at Beaufort.

## DEPARTMENTAL MAJOR

*Prerequisites.* Biology 11-12 or Biology 14 or consent of Director of Undergraduate Studies.

*Corequisites.* Mathematics 31, 32, or 34, Chemistry 11, 12, 151, and Physics 51, 52.

### For the A.B. Degree

*Major Requirements.* A minimum of eight courses, not including the above corequisites and prerequisites. They must include no fewer than five zoology courses; of which at least four must be other than independent study, tutorials, or seminars, and of which at least two must have related laboratory experience. They may include at most three non-zoology courses (100-level or above) in the appropriate related departments, with the prior approval of the Director of Undergraduate Studies. These courses in the Chemistry Department must be at a higher level than organic chemistry. No one course may be used to satisfy the requirements for zoology and another major, or for a zoology major and a second or third division distributional requirement.

## For the B.S. Degree

**Major Requirements.** Same as for the A.B. degree requirements except that the minimum of nine courses, not including the above prerequisites and corequisites, is required. They may include at most four non-zoology courses taken in appropriate related departments. All other qualifications and restrictions are identical to those of the A.B. degree.

**Areas of Concentration.** Molecular and cellular biology (cell physiology, cytology, genetics, development); organismic biology (comparative physiology, comparative and functional morphology, embryology); population biology (population genetics, speciation, systematics, biogeography); animal behavior; ecology (including biological oceanography and limnology).

**Departmental Handbook for Majors.** Any student who is interested should obtain a copy of the *Handbook for Zoology Majors* from the office of the Director of Undergraduate Studies. The handbook suggests appropriate combinations of courses for the above listed areas of study, describes the advising system and special programs, and gives the interests and background of the faculty.

**Interdepartmental Concentration.** An interdepartmental program (e.g., in cell and molecular biology, physical biology, marine biology, etc.) may be pursued instead of a departmental major. The Director of Undergraduate Studies in botany or zoology will arrange administrative responsibility for such programs.

## School of Nursing

Professor Wilson, *Dean*; Assistant Professor Brundage, *Coordinator of the Undergraduate Program*; Professors Fortune, Gratz, Minniear, and Stone; Associate Professors Hall, Hogue, Horton, Most, Norville-McIntire, Sayner, Schenk, and Woods; Assistant Professors Anderson, Askins, Bridge, Bullock, Davenport, Dery, Dietz, Gelein, Graedon, Hewitt, Humphrey, Kaufman, Lavacca, Lichy, Long, Lynds, McCool, Smith, Turner, White, and Yoder; Instructors Gallien, Morgan, Mullinix, Schafer, and Stefanics; Lecturers Harris, Messick, Myers, and Reckless; Clinical Faculty Barton, Burkett, Ewers, Hill, Honea, McGrath, Modigh, Oehler, O'Toole, Ritchie, Rosser, and Slawter

**97, 98. Human Ecology I and II.** An interdisciplinary course in the natural sciences covering the impact of a changing physical and biological environment upon man. Two courses. *Gratz*

**99. Introduction to Statistics in the Health Field.** Statistical concepts involved in the compilation, presentation, and analysis of health data. Measures and methods to describe, correlate, and make inferences about frequency distributions. Open to non-nursing majors. Priority will be given to sophomore nursing students. One course. *Staff*

**101,102. Theoretic and Scientific Bases of Nursing Practices.** Builds upon courses in human ecology to explore major theories of normal adaptive responses of individuals throughout the life cycle. Concepts relating to the nurse-patient relationship, the self system and the individual in the context of the supersystems of family, community, and society are explored. A systems theory framework is used to consider the individual and normal adaptation as well as major assaults to human integrity and responses to threats to health. Prerequisites: Nursing 97 and 98 or equivalent. Two courses. *Staff*

**103,104. Development of Nursing Skills and Attitudes.** Correlated with Nursing 101-102 by selection of clients of a variety of ages as exemplars of the individ-

ual's normal adaptation and response to assaults. Students will be giving nursing care to individuals in a variety of settings. Application of theory and concepts from Nursing 101 and 102 are facilitated in a weekly seminar of clinical groups. Nursing practice encompasses the development of psychomotor skills, cognitive skills, and attitudes essential to the process of nursing. Prerequisites: Nursing 97 and 98 or equivalent. Four courses. *Staff*

**105. Human Genetics and Societal Problems.** A course in the current state of research on birth defects, biochemical disorders, the human chromosome complement, and malformations resulting from mishaps in the chromosomes. Open to non-nursing majors. Pass/fail option. Fall only. One course. *Gratz*

**1215. Parenthood.** An investigation of parenting behavior with a focus on the meaning of experiences to the mother and father and the means by which individuals can maximize the positive potential of these experiences. Open to sophomores or above and non-nursing majors. Pass/fail option. One course. *Harris*

**125. Theory and Practice of Communication.** Students interview selected individuals for the purpose of practicing effective communication skills and methods of interviewing. When possible, the student develops an ongoing short term relationship to facilitate the individual's problem-solving process. Group conferences are utilized for faculty and peer supervision to maximize student learning to evaluate effectiveness of interactions. Classes utilize lectures, audiovisual demonstrations, gaming and simulation, and student-led discussions. Prerequisite: consent of instructor. Pass/fail option. One course. *Staff*

**144. An Introduction to Gerontology.** A study of the process of aging as it relates to the elderly with focus on physiological, sociopsychological changes, and economic status. Emphasis will be on selected areas such as theories of aging, demographic changes, and social policy. Open to sophomore through senior students including non-nursing majors. Pass/fail option. Spring only. One course. *Stone*

**146. Cross-Cultural Perspectives on Health Care Delivery.** Health care in several socio-cultural environments is explored, with emphasis on health delivery in developing regions. Theoretical bases for assessing and evaluating existing health programs and for predicting outcomes of planned change are examined and individual and agency motivations for exporting health care programs are compared. Techniques for maintaining physical and mental health in the field are presented. Open to sophomores and above. Pass/fail option. (Also listed as Anthropology 146.) One course. *Dietz and Graedon*

**155-156. Theoretic and Scientific Basis for Nursing Practice II.** A systems approach in these courses is used to explore the nursing of individuals with complex health problems, of families and the nature and function of groups with organizations and communities. Factors which influence professional nursing and the delivery of health care are discussed. Prerequisites: Nursing 102 and 104. Two courses. *Staff*

**157-158. Development of Nursing Skills and Attitudes II.** These clinical courses taken concurrently with Nursing 155-156 focus on the application of theories, processes, and concepts relevant to the nursing of individuals with complex health care problems and of families with preventive, supportive, and therapeutic nursing needs through use of the nursing process. Clinical experiences provide opportunities for students to assess, intervene, and evaluate individuals and families within the context of organizations and communities. Students intervene with hos-



pitalized and ambulatory patients. Organization and community theories, concepts, and processes will be applied when assessing the structure and function of a health care group in which they are participating. Prerequisites: Nursing 102 and 104. Four courses. *Staff*

**161. Applied Human Physiology.** An in-depth study of selected physiological processes significant to the health needs of man. Emphasis is upon those aspects of physiology that are reflected in patient care problems requiring effective nursing intervention. Prerequisite: Nursing 98 or equivalent. Pass/fail option. Not offered 1977-1978. Fall only. One course. *Gratz*

**162. Ecological Concepts and Their Applications to Environmental Health.** An in-depth study of current environmental problems significant to the health needs of man. Emphasis is on those ecological concepts that are reflected in patient health problems. Open to non-nursing majors. Pass/fail option. Spring only. Not offered 1977-1978. One course. *Gratz*

**169. Human Sexuality.** A study of the intrapersonal, interpersonal, and sexual aspects of an individual's existence and the forces shaping prevailing and future sexual expressions and human sexuality. Open to non-nursing majors. Pass/fail option. One course. *Mandetta, Reckless, and Woods*

**172. Psychosomatic Illness and Group Process.** A study of patients with psychosomatic and somatopsychic illness with opportunities to explore causal factors together with approaches for alleviation. Students assume responsibility for direct patient care under supervision and have the opportunity to attend group therapy sessions. Prerequisite: consent of instructor. Pass/fail option. One course. *Reckless*

**175. Loss and Loneliness.** Intervention with persons experiencing loneliness as a response to loss of specific relational provisions. Emphasis on deficit and creative responses to loss and mobilization of support systems to help individuals cope with loneliness. Pass/fail option. Fall only. One course. *Hall*

**178S. Advanced Concepts of Nursing for Patients with Cardiovascular Disease.** Examination and clinical exploration of the role of the nurse in providing health care to individuals with cardiovascular disease. Open to senior nursing students. Pass/fail option. One course. *Gelein*

**179. Nursing in Nephrology.** Planned experience providing nursing care for patients with clinical disturbances of renal function utilizing current treatment modalities in a variety of treatment settings. Open to second semester juniors and seniors in the nursing major. Pass/fail option. One course. *Brundage*

**183. Introduction to Methods of Research in Nursing.** Study of research in nursing and the implications for nursing practice. Prerequisites: basic statistics and Nursing 103 or consent of the instructor. Pass/fail option. One course. *Sayner*

**191, 192, 193, or 194. Independent Study.** Demonstration of self-direction in planning, implementing, evaluating, and reporting an independent learning experience. The required study for nursing majors must focus on nursing. Minimum of one course. Pass/fail option. *Staff*

**197, 198. Undergraduate Thesis.** Systematic study of a nursing problem. The study culminates in a written thesis. The method of study may involve research or may be limited to the student's critical review of others' work which bears upon the problem selected for study. Prerequisites: completion of the junior year with at least a *B+* average in all nursing courses, including electives in nursing, and consent of course coordinator. Two courses. *Hogue*

**205. Patient Assessment.** An introduction to the methods and techniques of eliciting and recording a health history and performing and recording a complete physical examination. Emphasis on the application of those skills to nursing practice. Open to senior nursing students and graduate nursing students. Pass/fail option. One course. *Messick*

**225. Work and Health.** Relationships between work and health are explored within a systems framework in which work in its organized form is viewed as stressful yet a significant offering of modern society for preventing even greater stress. Constraints and opportunities in work are considered through exploration of career, task, and organization stresses. Individual, family, and organizational strategies and tactics for dealing with the complex network of factors associated with work are presented. Open to senior and graduate students. Pass/fail option. One course. *Hogue*

**246. Nutrition in the Community Context.** Cultural and biological sources of variability in nutrition. Emphasis is on mutual influence of nutritional status and general health. Socioeconomic, cultural, and environmental aspects of nutrition are examined. One course. *Graedon*

**263. Crisis Intervention and Suicidology.** Exploration of crisis theories with methods of intervention in assisting individuals and families, before, during, and following the crisis. Discussions of specific human and environmental crises with emphasis on suicidal behavior. Application of theories and techniques through clinical practice. Open to graduate and senior nursing students with consent of instructor. Pass/fail option. One course. *Hewitt and Stefanics*

**269. Clinical Aspects of Human Sexuality.** A course designed to explore the nurse's role in education and counseling for a healthy sexuality. The course focuses on prevention of sexual problems by means of the educative process, anticipatory guidance, and counseling. Sexual dysfunction associated with life events, medical or surgical therapy, trauma, and hospitalization will be considered. In addition, adaptation to the sequelae of sexual relationships such as pregnancy, venereal disease, and abortion will be explored in the clinical setting. Prerequisite: Nursing 169 or consent of instructor. Pass/fail option. One course. *Woods*



**286. Thanatology.** An in-depth exploration of man's relationships to death. The course emphasizes feelings about death and examines and integrates clinical and theoretical materials from the social sciences and helping professions. Open to senior and graduate nursing students with consent of instructor. Pass/fail option. One course. *Gelein*

**288. Oncological Nursing.** An in-depth study of nursing the patient with cancer, focusing on prevention, detection, diagnosis, treatment and rehabilitation. Classes will be shared with the medical students enrolled in surgery 291C and/or 201C. These classes will be taught by the interdisciplinary oncology faculty from the Comprehensive Cancer Center. Open to seniors and graduate nursing students. Pass/fail option. One course. *Norville-McIntire*

## MAJOR IN NURSING

The major requirements are included in the minimum total of thirty-two courses listed under lower and upper division requirements on page 34. The specific courses in the upper division satisfying the nursing major that must be included are Nursing 101, 102, 103, 104, 155, 156, 157, 158, and 191, 192, 193, or 194.

## School of Engineering

### ENGINEERING (INTERDEPARTMENTAL)

**5, 6. Engineering Experiences.** In order to provide opportunities for engineering freshmen to become involved in engineering activity and to assist them in determining areas of interest, a number of engineering faculty members have developed miniprojects approved by the department of the faculty member. Prerequisite: consent of instructor. Pass/fail. Two quarter courses. *Staff*

**11. Engineering Graphics.** Graphical theory and techniques for engineering design and communication. Visualization and conventional representation of points, lines, surfaces, and objects using freehand sketches. Orthographic (including sectional and auxiliary), perspective, isometric, and oblique views. Introduction to working drawings. Elements of descriptive geometry, and graphic mathematics. Half-course. *Arges*

**51. Computers in Engineering.** Introduction to use of digital computers in engineering. Attributes of digital computer systems; program languages, flow charts; numerical analysis, including approximation and interpolation, searches and maximization, linear equations; applications to engineering; introduction to decision processes in engineering, including linear programming, optimization network methods; punched card operation; graphical output. Not open to students who have completed Computer Science 51. One course. *Garg, Medina, Owen, Shaughnessy, Tsui, and Utku.*

**72. Introduction to Systems Dynamics.** Unified treatment of mechanical, electrical, fluid, and thermal dynamic systems. Formulation and solution of differential equations; operators, transfer functions, and complex variables. Energy concepts for multiport system analysis. Simulation and analog solution of a variety of engineering problems. Prerequisites: Physics 51 and Mathematics 32. One course. *Garg, Macduff, or Wright*

**75. Mechanics of Solids.** Analysis of force systems and their equilibrium as applied to engineering systems. Stresses and strains in deformable bodies; mechanical behavior of materials; applications of principles to static problems of beams,



torsion members, and columns. Selected laboratory work. Prerequisites: Physics 51 and Mathematics 32. One course. *Arges, Palmer, and J.F. Wilson*

**83. Structure and Properties of Solids.** An introduction to materials science and engineering, emphasizing the relationships between the structure of a solid and its properties. The atomic and molecular origins of electrical, mechanical, and chemical behavior are treated in some detail for metals, alloys, polymers, ceramics, glasses, and composite materials. Prerequisites: Chemistry 11 and Mathematics 31. One course. *Cocks, Pearsall, and Shepard*

**101. Thermodynamics.** A rigorous development of engineering thermodynamics emphasizing the logical structure and manipulation. Classical and statistical concepts of the laws of thermodynamics. Energy and entropy analyses of thermodynamic systems. Property relationships. Chemically reactive systems. Application to power production and energy conversion. Prerequisites: Physics 51 and Mathematics 103. One course. *Elsevier or Harman*

**113. Current Topics in Materials Science.** Extension of the principles of Engineering 83 to areas of current interest, including biomaterials, fuel cells, composite materials, materials problems in energy conversion systems, computer systems, stress corrosion cracking, and other topics. Prerequisite: Engineering 83. One course. *Cocks, Pearsall, and Shepard*

**122. Transport Phenomena.** A unified treatment of momentum, energy, and mass transport from the continuum viewpoint. Parallel developments of the basic relationships, design equations, and engineering applications illustrate problem-solving and the usefulness of analogy between the three transport mechanisms. Selected laboratory work. Prerequisites: Physics 52 and Mathematics 103. One course. *Chaddock or Harman*

**123. Dynamics.** An introduction to the principles of particle and rigid body dynamics with engineering applications. Vector analysis used to describe the kinematics of motion in space and in a plane; the inertia tensor. Concepts of impulse-momentum and work-energy. An introduction to vibrations, wave motion, and Lagrange's equation. Prerequisites: Mathematics 103 and Physics 51. One course. *Dvorak and J. F. Wilson*

**135. Continuum Mechanics.** The concept of continua. Vectors. Cartesian Tensors. Equilibrium; stress, deformation, and velocity fields; compatibility. Isotropy. Constitutive equations. Virtual work principle. Mechanical properties of solids and fluids. Simple problems in elasticity, viscoelasticity, and plasticity. Prerequisites: Physics 51, Mathematics 104 or 111. One course. *Dvorak*

**145. Fluid Mechanics.** Physical properties of fluids; fluid-flow concepts and basic equations; continuity, energy and momentum principles; dimensional analysis and dynamic similitude; viscous effects; applications emphasizing real fluids. Selected laboratory work. Corequisite: Engineering 123 or Mechanical Engineering 123. One course. *Muga and J.F. Wilson*

**161, 162. Interdisciplinary Resources for Community Problem-Solving.** The objectives of this course are to assist the student in an understanding of the self, the interaction of the self with others and the environment, and in the analysis of information useful for decision-making. Problems in the community are used as a vehicle for developing group and individual approaches to the resolution of specific problems of interest to the students in the course. Prerequisite: consent of instructor. Two courses. *Artley*

**174. Technology Assessment and Social Choice.** Societal, economical, environ-



mental, psychological, and ethical considerations in the design and application of technological systems; techniques for technological forecasting; assessment methodology and recent case studies; impact evaluation; citizen participation and feedback; interdisciplinary team project. (Also listed as Public Policy Studies 174.) One course. *Garg*

**175. Aesthetics, Design, and Culture.** An examination of the role of aesthetics, both as a goal and as a tool, in a culture which is increasingly dependent on technology. Visual thinking, perceptual awareness, experiential learning, conceptual modeling, and design will be explored in terms of changes in sensory environment. Line, space, texture, color, and value will be experienced and analyzed through individual and group problem-solving and problem-formulating design projects. Fall semester. One course. *Pearsall*

**183, 184. Projects in Engineering.** Courses in which engineering projects of an interdisciplinary nature are undertaken. The projects must have engineering relevance in the sense of undertaking to meet human need through a disciplined approach under the guidance of a member of the engineering faculty. Prerequisite: consent of the instructor. Two courses. *Engineering Faculty*

## BIOMEDICAL ENGINEERING

Professor Pilkington, *Chairman*; Professor Clark, *Director of Undergraduate Studies*; Professors McElhaney, Nolte, Thurstone, and Wolbarsht; Associate Professors Barr, Evans, Hammond, and Wachtel; Assistant Professor von Ramm

Biomedical engineering includes the application of concepts and methods in the physical, mathematical, and engineering sciences to biology and medicine. This definition covers a broad spectrum ranging from formalized mathematical theory through experimental science to practical clinical applications. The purpose of the undergraduate program in biomedical engineering is to permit students to prepare themselves for graduate work in biomedical engineering, medicine, or biology. This program is flexible and can satisfy the requirements for entrance to graduate work in engineering, physiology, biology, or to medical school.

Opportunities for student research are available in the following biomedical engineering laboratories: The Cardio-Respiratory Systems Laboratory includes a PDP-12 digital computer, a PAR signal averager, and an analog computer. Computer science techniques are utilized in acquiring, processing, and modeling biological data. Research in the Biomedical Materials Laboratory is directed toward the development of materials suitable for use in biological environments such as the vascular system. Biomedical Engineering in Pediatric Cardiology measures electrical activity of the heart in animals and humans, to increase the basic knowledge of the heart itself. The Optics and Acoustics Laboratories are employed for research and instruction in the biomedical application of these fundamental areas. Ultrasound instrumentation measures and images biological tissue structures. The Electrobiological Laboratory explores the communication of information between individual nerve cells in prototypical brains. Optical, mechanical, and electronic equipment is used in recording neural activity, and computational equipment is employed for data analysis and simulation. The Biomechanics Laboratory is equipped to measure biomechanical responses of tissues and organs, gait parameters, and test and developmental facilities for prosthetic devices. A cell biomechanics laboratory is equipped for the study of the physical-chemical behavior of the molecular complexes which constitute cells.

**101. Electrobiological.** An exploration of the biophysical and chemical bases of bioelectricity as well as the technologies of bioelectric signal evocation, recording, analysis, and simulation. Topics will range from the ionic mechanisms of mem-

brane potentials to the bioelectric control of neuro-muscular systems. Prerequisite or corequisite: Physics 52. One course. *Wachtel*

**110. Introductory Biomechanics.** Static and dynamic analysis of biological systems; analysis of gait and locomotion; balistocardiography; biomechanical aspects of various sport activities, diving, and jumping; power, work, and energy concepts applied to the human body; strength and properties of tissue; and injury mechanisms and tolerance. Prerequisite: Math 31. One course. *McElhaney*

**111. Introduction to Biomedical Physics.** Engineering and physical science approach to human physiology. Specific topics include: (1) cell environment interaction (metabolism, membrane physical chemistry, dynamics, and information transmission); (2) oxygen transport system (cardiovascular, respiratory, and blood); (3) water balance (renal system); (4) control integration (endocrine and neural). One course. *Barr, Clark, or McElhaney*

**125. Mechanics of Biological Materials.** An introduction to mechanics of solid, semi-solid, and liquid material elements of biological tissues. The relationship of continuum properties to molecular arrangements will be made through statistical thermodynamics. Prerequisite: Engineering 135 or equivalent. One course. *Evans*

**131. Statistical and Computational Methods in Data Analysis I.** Introduction to discrete-time systems and probability. Difference equations, sampling theorem, discrete Fourier Series, z-transforms, and frequency spectra. Probability, random variables, probability density functions, moments, correlation, and transformation of random variables. Prerequisite: Mathematics 103. One course. *Nolte and Pilkington*

**132. Statistical and Computational Methods in Data Analysis II.** Random discrete-time signals, spectral analysis of random signals, detection and estimation of signals in noise. Prerequisite: Mathematics 103 and background in probability. (Also listed as Electrical Engineering 132.) One course. *Nolte and Pilkington*

**163, 164. Biomedical Electronics and Measurements.** A study of the basic principles of biomedical electronics and measurements with emphasis on the operational performance and selection of transducers, instruments, and systems for biomedical data acquisition and processing. Selected laboratory work emphasizes the measurements of specific physiological events. Prerequisite: Electrical Engineering 63 or Engineering 72. Two courses. *Hammond, Thurstone, or von Ramm*

**172. Biomedical Transfer Processes.** An introduction to transfer processes and life systems with emphasis on biological interactions of artificial materials and environmental studies. One course. *Clark*

**191, 192. Projects in Biomedical Engineering.** This course is available to seniors who express a desire for such work and who have shown aptitude for research in one area of biomedical engineering. Half-course to two courses. *Staff*

**201. Analysis of Bioelectric Phenomena.** Fundamentals of bioelectric modeling with particular emphasis on neural and cardiovascular systems exhibiting phenomena varying from cellular to the whole organism level. One course. *Wachtel*

**202. Energy and Rate in Biological Processes.** An introduction to biomedical thermodynamics and transfer processes with particular emphasis on environmental studies, hyperbaric exposure, and the functions of natural and artificial organs. Not open to students who have had Biomedical Engineering 172. One course. *Clark*

**203. Bioelectric Potentials and Field Theory.** A study of bioelectric potentials and models for their generation. Analysis from a field theoretic point of view with

particular emphasis on formulations that are amenable to computation. One course. *Pilkington*

**204. Real Time Measurement and Control of Heart Events.** Specification of procedures and devices from biological considerations, and their design and construction. Consideration of amplifiers, analog-digital conversion, computer interfaces, and associated programming. Evaluation of selected examples for accuracy, complexity, and cost. One course. *Barr*

**207. Experimental Mechanics.** Experimental studies and techniques basic to mechanics, stress-strain measurements and transducers, dynamic force, acceleration and flow measurements and analysis, viscoelastic behavior and modeling, high speed photographic methods, general applications to biomechanics including gait and analysis, head injury, automotive safety criteria, and blood flow. One course. *McElhaney*

**223. Biomedical Materials and Artificial Organs.** The use of artificial organs to replace or augment natural function in pumping and oxygenation of blood, removal of nitrogenous wastes and other toxins, and prostheses which have mechanical, chemical, or cosmetic function. Emphasis is placed on molecular architecture of materials for use in biological environment and optimization of parameters of materials which determine their utility in varying applications. One course. *Clark*

**225. Mechanics of Cellular Components.** Concepts of solid, semi-solid, and liquid mechanics applied to the study of cell components, e.g., membranes, cytoplasm, organelles, nuclei, etc. Transition from molecular structure to continuum properties will be emphasized. Prerequisite: consent of instructor. One course. *Evans*

**230. Biomechanics.** Kinematic models of human motions, mechanical properties of bone and soft tissues, hydrodynamics of micturition, load directed growth mechanisms, human tolerance to impact and vibration, head injury criteria applied to helmet design. Prerequisite: consent of instructor. One course. *McElhaney*

**241, 242. Information Organization and Retrieval.** (Also listed as Computer Science 241, 242.) Two courses. *Hammond*

**243. Computers in Biomedical Engineering.** An in-depth study of the use of computers in biomedical applications. Hardware, software, and applications programming will be considered. Data collection, analysis, and presentation will be studied within application areas such as monitoring, medical records, computer-aided diagnoses, computer-aided instruction, M.D.-assistance programs, laboratory processing, wave form analysis, hospital information systems, and medical information systems. One course. *Hammond*

**252. Marine Electrobiology.** The physiology and behavioral consequences of bioelectric activity ranging from the cell membrane to the interanimal communication level. Laboratory work deals with bioelectric recording and stimulation techniques with particular emphasis placed on electrophysiological studies of marine organisms wherein cellular correlates of animal behavior are clearly seen. Ionic basis of bioelectric signals, transmission of signals within and between cells, relation of bioelectric signals to particular behavioral patterns, effects of externally applied electric fields, bioelectric communication and navigation systems. Prerequisites: consent of instructor. Summer at Beaufort. (Also listed as Physiology and Pharmacology 222.) One and one-half courses. *Wachtel and Wolbarsht*

**265. Advanced Topics in Biomedical Engineering.** Advanced subjects related to programs within biomedical engineering tailored to fit the requirements of a



small group. Prerequisites: consent of chairman and instructor under whom the work will be done. One course. *Staff*

## Departmental Major in Biomedical Engineering

The major requirements are included in the minimum total of thirty-two courses listed under general requirements and departmental requirements. The following specific courses must be included: Biomedical Engineering 101, 111, 125, 131, 132, 163, and 164.

## CIVIL ENGINEERING

Professor Muga, *Chairman*; Professor Brown, *Director of Undergraduate Studies*; Professors Dvorak, Utku, and Vesic; Associate Professors Palmer, Vesilind, and J.F. Wilson; Assistant Professors Arges, Medina, and Tsui; Adjunct Professor Saibel; Adjunct Assistant Professor Warner; Instructors Abo-Hamd and Hasit; Lecturers Francisco, Gilbert, Lathrop, and Rimer

Civil engineering involves the conception, design, analysis, and building of constructed facilities. However, modern civil engineers may find themselves engaged in such complex problems as trafficability of planetary surfaces, environmental planning for a community, or optimization of an urban transportation system. There are seven major speciality areas of civil engineering at Duke. Environmental engineering deals with the quality of human environment as affected by water supply and waste-water treatment and disposal. Geotechnical engineering is concerned with interaction between engineering structures and the earth's crust as well as with structures constructed of earth as a material. Mechanics and materials engineering is the study of the behavior of materials under various conditions of loading and environment. Ocean engineering deals with the development and use of marine resources. Structural engineering is concerned with economical and safe design of engineering structures. Urban engineering encompasses a broad spectrum of integrated technological problems such as land and city planning and development, mass transportation, and public health and safety. Water resources engineering is concerned with the usage, preservation, and replenishment of water resources. In addition, a student may elect a general program of civil engineering studies or an interdisciplinary program of management sciences combined with civil engineering. The student may also pursue a degree with a double major in civil engineering and the policy sciences, by additionally satisfying the requirements of the Institute of Policy Sciences.

The civil engineering program at Duke is supported by several laboratories for instruction and research. The Structural Engineering Laboratory has universal testing machines with capacities to 400,000 pounds; hardness testers; and machines for testing torsion, fatigue, and impact. The department has facilities for the construction and testing of structural models, including medium-speed electronic equipment for the measurement and recording of strains and displacements. The Soil Mechanics Laboratory includes modern testing equipment and instruments, such as static and dynamic and model testing accessories, as well as a triaxial shear apparatus, designed for testing soil and rock at confining pressures up to 100,000 pounds per square inch. The Fluid Mechanics Laboratory equipment includes a water wave flume with paddle-type variable frequency, constant amplitude, wave generator, and a variety of sensors. The Sanitary Engineering Laboratory is equipped for determining the characterization of waters and wastewaters and for applying biological, chemical, and physical treatment methods to improve their quality. The Materials Laboratory deals with the physical properties and stress-deformation characteristics of bituminous mixtures and concretes. The Urban Sys-



tems Laboratory is equipped with a PDP-8 digital computer and a teletype terminal. The department has a representative collection of modern surveying equipment.

**16. Surveying for Engineers.** The theory and application of measurements required for planning, design, and construction of engineered facilities. Transit-tape and stadia surveys; differential and profile leveling; traverse computations; topographic mapping. Laboratory included. Corequisite: Mathematics 31. Half-course. *Arges*

**116. Transportation Engineering.** The role and history of transportation. Introduction to the planning and design of links, vehicles, and terminals of all transportation modes. Principles of traffic engineering and route location and design. Planning studies and economic evaluation. Prerequisite: junior or senior standing; consent of instructor for non-engineering students. One course. *Gilbert*

**117. Public Systems Planning.** The systems approach to public policy planning. Mathematical modeling and computer simulation techniques. Estimation, forecasting, and decision-making. System evaluation models. Decision processes in the land-use, transportation, public utilities, and urban service sectors. Prerequisite: Mathematics 32. One course. *Staff*

**123. Water Resources Engineering.** Hydraulics of pressure conduits and measurement of flow, compound pipe systems, analysis of flow in pressure distribution systems, descriptive and quantitative hydrology applied to problems of irrigation and drainage, open channel flow, reservoirs and distribution system storage. Selected laboratory work. Prerequisite: Engineering 145. One course. *Medina and Muga*

**124. Environmental Engineering.** Qualitative and quantitative physical, chemical, and bacteriological characterization of water and wastewater. Introduction to water treatment processes and wastewater collection, treatment and disposal systems; elements of environmental sanitation. Laboratory included. Field trips to be arranged. Corequisite: Engineering 145 or consent of the instructor for non-civil engineering students. One course. *Rimer and Vesilind*

**127. Environmental Pollution Control.** A study of the environment—causes and effects of air, land, and water pollution. Interactions between the environment and stresses to which it is subjected as a consequence of growth and concentration of populations and their increasing demands on natural resources. Solid waste, recycling, noise pollution, and environmental ethics. For non-civil engineering students. One course. *Medina and Vesilind*

**131. Theory of Structures.** A first course in the application of mechanics to the analysis of plane and space structures; a unified treatment of statically determinate and indeterminate structural systems. Prerequisites: Mathematics 103 and Engineering 75. One course. *Brown*

**133. Structural Design I.** Nonhomogenous materials. Determination of physical and mechanical properties of construction materials. Theory and design of compression and flexural members. Emphasis on ultimate strength theory for concrete. Timber design using mechanical fasteners. Laboratory exercises include concrete aggregate evaluation, concrete mix design, and structural timber tests. Prerequisite: Civil Engineering 131. One course. *Brown*

**134. Structural Design II.** Design in metals, primarily steel. Properties of materials as criteria for failure. Tension, compression, and flexural members. Bolted and welded connections, including eccentric connections. Built-up members. Design by

elastic and plastic methods. Selected problems to include computations and drawings. Prerequisite: Civil Engineering 131. One course. *Palmer*

**139. Introduction to Soil Mechanics.** Origin and composition of soils, soil structure. Flow of water through soils; capillary and osmotic phenomena. Soil behavior under stress; compressibility, shear strength. Elements of mechanics of soil masses with application to problems of bearing capacity of foundations, earth pressure on retaining walls, and stability of slopes. Laboratory included. Prerequisites: Engineering 83 and 145. One course. *Tsui and Vesic*

**141, 142. Special Topics in Civil Engineering.** Study arranged on a special topic in which the instructor has particular interest and competence as a result of research and professional activities. Prerequisites: consent of the instructor and the Director of Undergraduate Studies. Each half-course or one course. *Staff*

**146. Professional Engineering.** A study of general topics related to the professional practice of engineering with emphasis on economic and legal aspects. Monetary basis for engineering decisions, economic alternatives; contracts, specifications, ethics; quantity and cost estimates; scheduling by the Critical Path Method. Presentation of student papers on current or unique engineering topics. Prerequisite: junior or senior standing in engineering. One course. *Palmer*

**197, 198. Projects in Civil Engineering.** These courses may be taken by junior and senior engineering students who have demonstrated aptitude for independent work. Prerequisites: consent of the instructor and the Director of Undergraduate Studies. Each half-course or one course. *Staff*

**201. Advanced Mechanics of Solids.** Cartesian tensors, dyadics, and matrices. Analysis of states of stress and strain. Conservation laws and field equations. Constitutive equations for elastic, viscoelastic, and elastic-plastic solids. Formulation and solution of simple problems in elasticity, viscoelasticity, and plasticity. Corequisite: Mathematics 285 or equivalent. One course. *Dvorak*

**204. Plates and Shells.** Differential equation and extremum formulations of linear equilibrium problems of Kirchhoffian and non-Kirchhoffian plates of isotropic and orthotropic material. Solution methods. Differential equation formulation of thin shell problems in curvilinear coordinates; membrane and bending theories; specialization for shallow shells, shells of revolution, and plates. Extremum formulation of shell problems. Solution methods. Prerequisites: Mathematics 104, and Engineering 75 or Engineering 135, or consent of instructor. One course. *Utku*

**205. Elasticity.** Introduction to linear theory of elasticity. Constitutive equations for anisotropic and isotropic elastic solids. Formulation and solution of torsion, bending, and plane problems by semi-inverse, complex potential, and variational methods. Three-dimensional problems. Prerequisite: Civil Engineering 201 or equivalent. One course. *Dvorak*

**206. Advanced Mechanics of Solids II.** Continuum theories for time-independent and time-dependent materials. Formulation and solution of boundary value problems; analytical and numerical techniques, applications. Prerequisite: Engineering 135 or Civil Engineering 201. One course. *Dvorak*

**209. Structural Dynamics.** Vibration and stability (small and global) of discrete and continuous linear systems; introduction to nonlinear theory, parametric and random excitation. Applications include response studies of machines, ships, pipelines, bridges and buildings to man-made and nature-induced loadings. (Also listed as Mechanical Engineering 209.) One course. *J. F. Wilson*

**210. Intermediate Dynamics.** (Also listed as Mechanical Engineering 210.) One course. *Macduff or J. F. Wilson*

**212. Mechanical Behavior of Materials.** Mechanical behavior and its relationship to microstructural deformation and fracture processes in polycrystalline, polymeric, and composite materials. Influence of temperature, strain rate, and environmental conditions on material behavior. Fracture mechanics and its application to brittle and ductile fracture, and fatigue in structural metals, polymers, composites, and concrete. Prerequisite: Civil Engineering 201. One course. *Dvorak*

**215. Urban and Regional Geography.** Human settlements and locational patterns. Location theory and land-use systems. Normative and descriptive location decisions. Location and impact of constructed facilities. Spatial interaction and network structure. Geography of transportation and environmental quality. One course. *Staff*

**216. Transportation Planning and Policy Analysis.** Issues in policy planning and decision-making in urban and rural transportation systems. Transportation legislation. Public transportation alternatives with emphasis on public transit and paratransit solutions. Prerequisite or corequisite: Civil Engineering 116 or consent of instructor. (Also listed as Public Policy Sciences 254.) One course. *Lathrop*

**217. Transportation Systems Analysis.** The transportation systems planning process. Quantitative analysis, mathematical modeling and computer simulation techniques for short and long-range planning and evaluation of transportation systems. Prerequisite or corequisite: Civil Engineering 116 or consent of instructor. One course. *Staff*

**218. Engineering-Economic Analysis.** Methods of analysis applicable to the economic evaluation of both pre-construction project plans and post-construction project outcomes. Principles of engineering economics with regard to time-dependent costs and benefits. Techniques of economic evaluation and comparisons of multiple alternatives. Concepts of welfare economics with regard to public works development. Identification and measurements of both monetary and non-monetary consequences of public works. Student projects involving the analysis and evaluation of public investments. One course. *Warner*

**221. Incompressible Fluid Flow.** Steady and unsteady pipe flow; theories of turbulent flow; water hammer theory and control; surge tanks; air chambers; the analysis and control of fluid systems; effect of resistance; tapered conductors. One course. *Muga*

**222. Open Channel Flow.** Basic principles. Selected flow problems and practical solutions; gutter and inlet flows, flow over spillways, flow into estuaries and bays. Design of open channel structures, river hydraulics. Design of flood control and navigation structures; culverts, bridge openings, and energy dissipators. One course. *Muga*

**223. Flow Through Porous Media.** Theory of miscible and immiscible fluid displacement processes. Derivation and solution methods. Selected problems in stability, fingering, and capillarity. Applications; saline water intrusion, secondary recovery processes, seepage through earthen dams, dewatering of construction sites, and well point operation. One course. *Muga*

**224. Coastal and Offshore Engineering.** Basic analytical concepts; wave phenomena, theory of surface water wave motion, wave modification, and wave spectra. Effects of waves on structures emphasizing design of marine facilities and other selected problems. One course. *Muga*



**225. Engineering Hydrology.** Study of processes governing the origin, distribution, and depletion and replenishment of water resources, and application of this knowledge to the solution of water supply and drainage problems. Topics include the hydrologic cycle, hydrometeorology, precipitation runoff, hydrograph analysis, evapotranspiration, infiltration, groundwater, runoff, stream flow, groundwater recharge, and hydrologic measurements. One course. *Medina*

**231. Structural Engineering Analysis.** The analysis of fundamental structural forms including arches, suspension cables, and members of variable inertia. Influence lines for indeterminate structures. Introduction to matrix analysis. Prerequisites: Civil Engineering 131 and Mathematics 104, or consent of instructor. One course. *Brown*

**232. Reinforced Concrete Design.** Design of concrete members considering flexural deflection, cracking, and torsional shear. Design of retaining walls, deep beams and shear walls, flat slabs, and flat plates. Code limitations evaluated. Prerequisite: Civil Engineering 133. One course. *Brown*

**233. Prestressed Concrete Design.** A critical review of research and recent developments in prestressed concrete design. Prestressed tanks, beams, and columns; partial prestressing and composite design. Prerequisite: Civil Engineering 133. One course. *Brown*

**234. Structural Design in Metals.** Design of metal structures using both elastic and plastic theories. Application to plate girders, bridge trusses, and building frames. Interpretation and justification of building codes and specifications. Planning, preliminary design, and organization of design procedures. Prerequisite: Civil Engineering 134. One course. *Palmer*

**235. Foundation Engineering.** An introduction to methods of analysis, design, and construction of foundations. Bearing capacity and settlement of shallow and deep foundations. Soil exploration; excavation and bracing; drainage and stabilization; and underpinning. Foundation vibrations. One course. *Vesic*

**236. Earth Structures.** An introduction to methods of analysis, design, and construction of earth structures such as dams, embankments, cuts, canals, and air-field and highway pavements. Selection of materials, soil compaction, and stabilization. Theory of seepage, design of wells and drainage collectors. Slope stability and related problems. Theory of layered systems and pavement design procedures. One course. *Tsui*

**238. Rock Mechanics.** Behavior and properties of rock as an engineering material; failure of rock. Design and construction of underground structures and slopes in rock; design of rock abutments for dams. Laboratory and field rock testing techniques. Prerequisite: Civil Engineering 139 or consent of instructor. One course. *Staff*

**241. Environmental Engineering Chemistry and Biology.** Inorganic and organic chemistry as applied to water and wastewater treatment. Chemical equilibria and kinetics. Population dynamics and energy transfer in metabolic systems. Instrumental analysis, including spectrophotometry, chromatography, and atomic adsorption. Atmospheric chemistry and analytical methods. Prerequisite: Civil Engineering 124. One course. *Francisco*

**243, 244. Sanitary Engineering Unit Operations and Process Design.** Fundamental bases for design of water and waste treatment systems, including transport, mixing, sedimentation and filtration, gas transfer, coagulation, and biotreatment



processes. Prerequisite: Civil Engineering 124 or consent of instructor. Two courses. *Vesilind*

**246. Sanitary Engineering Design.** The study of water resources and municipal water requirements including reservoirs, transmission, treatment, and distribution systems; reservoirs, transmission, treatment, and distribution systems; industrial wastewaters. The course includes the preparation of a comprehensive engineering report encompassing all aspects of municipal water and wastewater systems. Field trips to be arranged. Prerequisite: Civil Engineering 124 or consent of instructor. One course. *Rimer and Vesilind*

**247. Air Pollution Control.** The problem of air pollution, with reference to chemical and biological effects. Measurement and meteorology of air pollution. Air pollution control methods. Noise pollution, odor, and air pollution law. One course. *Vesilind*

**248. Solid Waste and Resource Recovery Engineering.** Engineering design of resource recovery systems including traditional and advanced technologies. Sanitary landfills and incineration of solid wastes. Energy recovery and recycling processes. Application of systems analysis to collection of municipal refuse. Collection, treatment, and disposal of solid wastes from wastewater treatment. Prerequisite: Civil Engineering 124 or consent of instructor. One course. *Rimer*

**249. Resource Recovery Systems Management.** The social, economic, legal, political, and administrative aspects of resource recovery from municipal solid wastes. Economic applications and systems management. Assessment methodologies. Federal and state legislation. Public versus private sector interests. Policy issues. Case studies. Prerequisite: consent of instructor. One course. *Warner*

**250. Engineering Analysis.** Formulation of mathematical models selected from a wide variety of engineering disciplines; optimization; use of infinite series, finite difference calculus, energy methods, and digital computers as problem-solving techniques. One course. *J. F. Wilson*

**251. Systematic Structural Analysis I.** Computer analysis techniques for the equilibrium problems of solids and structures. Describing the problems to a digital computer. Transformation matrices. Recapitulation of energy theorems. Stiffness and flexibility relations of structural elements in discrete space and continuum. Systematic analysis of equilibrium problems by displacement and force methods. Errors. Prerequisites: Mathematics 104, and Civil Engineering 131 or Engineering 135, or consent of instructor. One course. *Utku*

**252. Systematic Structural Analysis II.** Computer analysis techniques for the equilibrium, eigenvalue and propagation problems of solids and structures. Representation of initial stresses. Handling of geometrical nonlinearities in equilibrium problems. Buckling. Handling of material nonlinearities. Incremental load techniques. Time dependent materials. Representation of inertial and damping forces. Stationary and transient vibrations. Random vibrations. Prerequisite: Civil Engineering 251 or consent of instructor. One course. *Utku*

**265. Advanced Topics in Civil Engineering.** Opportunity for study of advanced subjects relating to programs within the Civil Engineering Department tailored to fit the requirements of a small group. One course. *Staff*

### **Departmental Major in Civil Engineering**

The major requirements are included in the minimum total of thirty-two courses listed under the general requirements and departmental requirements.

Specific courses which must be included are: Engineering 11 (half-course), 51, 75, 83, 123, 145; Civil Engineering 16 (half-course), 116, 123, 124, 131, 133, 134, and 139.

## ELECTRICAL ENGINEERING

Associate Professor Hacker, *Chairman*; Associate Professor Joines, *Director of Undergraduate Studies*; Professors Artley, Kerr, Marinos, Nolte, Owen, Pilkington, Thurstone, Wang, and Wilson; Assistant Professors George and Shubert

Electrical Engineering is a broadly based discipline dealing with the processing, control, and transmission of information and energy by making use of the electrical and magnetic forces of nature.

The flexibility of the electrical engineering curriculum permits a student to concentrate in such areas as: computers and information processing, communications and control systems, electromagnetic fields and waves, electronic networks, and solid state sciences. A student may also plan a double-major program with secondary concentration in such fields as computer science, mathematics, history, public policy sciences, biomedical engineering, and many others. Students with interests such as premedicine, prelaw, management, economics, art, music, psychology, and social systems can be accommodated within the curriculum through programs individually designed to provide specific skills and methods, but in a way which encourages students to think creatively in terms of fundamental concepts.

Opportunities for research and project work are available in the following research and teaching laboratories: the solid state sciences laboratories are concerned with both the microscopic and macroscopic properties of materials with emphasis on electric and magnetic phenomena such as magnetic susceptibility, paramagnetic resonance, electrical conductivity, and magnetic ordering transitions. In the Field and Matter Interaction Laboratory studies are being conducted to determine the nature of stimulated and spontaneous electromagnetic radiation from organic and inorganic materials. The Electronics Laboratory is used for the study of the physical behavior of basic electronic components and of advanced electronic devices and circuits. The Spacecraft Systems Laboratory combines many phases of electrical engineering in solving problems encountered in the electrical systems on modern spacecraft. The Controlled Personal Environment Laboratory provides experiential learning activities directed to the understanding of the self and the interaction of the self with others in a carefully controlled physical environment. In the Electromagnetic Waves Laboratory studies are made on microwave networks and the interaction of electromagnetic waves with biological systems. The minicomputer laboratories provide the opportunity for experience in the operation of two small computers in an instructional and research environment. The Digital Systems Laboratories are utilized for research and instruction in digital systems design and simulation. The Adaptive Information Processing Laboratory is concerned with the formulation and performance evaluation of adaptive algorithms for extracting signals and information from noise.

**11, 12. Undergraduate Research in Electrical Engineering.** An elective program in which undergraduate students participate in an ongoing program of research with electrical engineering faculty members. The research topic pursued by the student is arranged by mutual agreement between the student and the participating faculty member. For freshmen only. Fall and spring semesters. Quarter-course. *Staff*

**42. Introduction to Digital Systems.** A course designed for students who have no previous exposure to switching (Boolean) algebra. Its main objective is to introduce basic notions of switching algebra and to demonstrate the application of these

concepts to digital systems design. The operational characteristics of major digital subsystems such as memories, central processing elements, arithmetic units, and input/output devices are discussed in detail, and a general-purpose digital computer system with a simple architecture is functionally analyzed. Selected laboratory work is required. Fall and spring semesters. (Also listed as Computer Science 42.) One course. *Marinos or Owen*

**43. Electronic Instruments and Devices.** The theory of operation and applications of electronic instruments and devices most commonly used by scientists and engineers are presented. Topics include: d.c. and a.c. circuits, transducers, measurements, diode and transistor applications, operational amplifiers, and radiation detectors and generators. Three class sessions and one computation or laboratory session. Prerequisite: Mathematics 31. May not be taken concurrently with or after Electrical Engineering 63. Spring semester. One course, *Joines*

**51, 52. Undergraduate Research in Electrical Engineering.** For sophomores only. See Electrical Engineering 11, 12. Fall and spring semesters. Quarter course. *Staff*

**63. Electric Networks.** The physical basis for electrical network models. Conductors and semiconductors; energy storage elements. Network topology and equations. Transient response due to initial conditions and step function inputs. Exponential forcing functions and the sinusoidal steady state. System functions; network theorems; power and energy in steady state circuit analysis. Prerequisites: Mathematics 32 and Physics 51 or consent of the instructor. Fall and spring semesters. One course. *Kerr and Wang*

**101, 102. Undergraduate Research in Electrical Engineering.** For juniors only. See Electrical Engineering 11, 12. Fall and spring semesters. Quarter course or half-course. *Staff*

**103. Introduction to Nonlinear Network Theory.** Introduction to theory and techniques for analysis and synthesis of nonlinear circuits. Characterization of 2-, 3-, and n-terminal nonlinear network elements. Laws for interconnecting elements and determining equilibrium equations. Operating points, driving-point and transfer-characteristic plots. Graphical and numerical analysis and synthesis of d.c. and a.c. nonlinear resistive functional networks. Nonautonomous first-order nonlinear networks, and autonomous second-order nonlinear networks. Method of isoclines. Some laboratory and computer simulations. Prerequisite: Electrical Engineering 63. Fall semester. One course. *Owen or Wilson*

**113. Introductory System Theory.** Fourier series. Fourier and Laplace transforms; transfer function analysis. Impulse functions; impulse response of systems; convolution and time domain analysis. Discrete time models and computer simulation of continuous systems. Multiple input-output systems; introduction to state variable analysis. Prerequisites: Electrical Engineering 63. Fall and spring semesters. One course. *Kerr and Wang*

**132. Statistical and Computational Methods in Data Analysis II.** (Also listed as Biomedical Engineering 132). One course. *Nolte or Pilkington*

**143. Introduction to Electromagnetic Fields.** Review of vector analysis. Introduction to Maxwell's equations. Electrostatic and magnetostatic fields and their sources. Electromagnetic power, energy, and the Poynting theorem. Prerequisites: Mathematics 104 or 111 and Physics 52. Fall semesters. One course. *Hacker or Joines*

**151, 152. Undergraduate Research in Electrical Engineering.** For seniors only.



See Electrical Engineering 11, 12. Fall and spring semesters. Quarter or half-course. *Staff*

**155, 156. Special Topics in Electrical Engineering.** Study of selected topics in electrical engineering tailored to fit the requirements of a small group. Prerequisites: consent of the Director of Undergraduate Studies and the instructor. Each half-course or one course. *Staff*

**157. Introduction to Switching and Automata Theory.** This course introduces techniques for the analysis and design of combinational and sequential networks. Discrete mathematical systems; elements of code theory; threshold logic; functional decomposition; minimum-complexity combinational and sequential networks; asynchronous and clocked sequential systems; iterative switching structures; Turing machines; fault diagnosis techniques. Selected laboratory work. Usually open to juniors and seniors. Fall semester. (Also listed as Computer Science 157.) One course. *Marinos*

**161. Electronic Circuits.** Graphical and mathematical modeling of electronic devices such as diodes, bipolar-junction and field-effect transistors, and vacuum tubes; techniques for the analysis and design of electronic circuits with emphasis on graphical, piece-wise linear, and small-signal methods; applications of these methods to particular circuits, including regulators, bias-point stability, amplifiers, and switching circuits; computer simulation of electronic circuits using ECAP. Three class sessions and one computation or laboratory session. Prerequisite: Electrical Engineering 63. Spring semester. One course. *George or Wilson*

**162. Electromechanical Energy Conversion.** Principles of energy storage and conversion utilizing magnetic and electric fields; analytical treatment of dynamic equations of motion, including the Euler-Lagrange approach; applications to the design of electromechanical transducers and rotating machines. Three class sessions and one laboratory. Prerequisite: Electrical Engineering 113. One course. *Trickey*

**164. Electromagnetic Fields and Waves.** Discussion of plane waves in insulating and conducting media. Reflection and refraction of plane waves. Transmission lines and waveguides for practical applications. Introduction to radiation and antennas. Prerequisite: Electrical Engineering 143. One course. *Joines or Hacker*

**173, 174. Projects in Electrical Engineering.** A course which may be undertaken only by seniors who are enrolled in the Graduation with Distinction program, or who show special aptitude for individual project work. Prerequisite: consent of the Director of Undergraduate Studies. Elective for electrical engineering majors. Half-course to two courses. *Staff*

**185. Pulse and Digital Electronics.** Generation and shaping of waveforms encountered in information processing systems, such as radar, computer, control, and instrumentation systems. Typical circuit functions included are linear and nonlinear wave shaping, pulse and time-base generation, time delay, counting, and gating. Emphasis on the application of semiconductor devices to the realization of circuit functions. Three class sessions and one computation or laboratory session. Prerequisite: Electrical Engineering 161. One course. *George*

**186. Modulation Systems and Noise.** Analysis and design of modulation systems. Description of deterministic and probabilistic signals; power spectra; sampling theory; amplitude-, frequency-, and pulse-modulation systems, and pulse-modulation techniques; comparison of various modulation systems. Selected laboratory work. One course. *Nolte or Owen*



**188. Dynamics of Electrochemical Energy Conversion.** An analytical and experimental study of the dynamic characteristics of electromechanical energy conversion devices that are utilized in both control and power applications. Three class sessions and one three-hour laboratory. Prerequisite: Electrical Engineering 162. One course.

**196. Microwaves and Quantum Electronics.** A study of the special field and circuit techniques required at microwave frequencies; electromagnetic wave propagation in unbounded and bounded media; transmission and reflection properties of various microwave networks. Equivalent circuits and matrix methods will facilitate analysis. Discussion of microwave amplifiers and oscillators, including klystrons, magnetrons, traveling-wave tubes, and masers. Selected laboratory experiments. Three class sessions and one computation or laboratory. Prerequisite: Electrical Engineering 164. One course. *Joines or Shubert*

**199. Linear Control Systems.** Analysis and design of feedback control systems. Block diagram and signal flow graph system models. Servomechanism characteristics; steady state errors; sensitivity to parameter variations and disturbance signals. Time domain performance specifications. Stability. Root locus, Nyquist, and Bode analysis; design of compensation circuits; closed loop frequency response determination. Introduction to time domain analysis and design. Prerequisite: Electrical Engineering 113 or consent of instructor. Spring semester. One course. *Kerr or Wilson*

**203. Random Signals and Noise.** Introduction to mathematical methods of describing and analyzing random signals and noise. Review of basic probability theory; joint, conditional, and marginal distributions; random processes. Time and ensemble averages, correlation, and power spectra. Optimum linear smoothing and predicting filters. Introduction to optimum signal detection and parameter estimation. Fall semester. (Also listed as Computer Science 203.) One course. *Kerr or Nolte*

**204. Information Theory and Communication Systems.** Information and entropy and their application in communication situations. Noise and channel capacity, coding, and the fundamental theorem of information theory. Continuous channels and transmission of band-limited signals. Comparisons of various practical modulation techniques from the standpoint of information rate and error probability. Spring semesters, 1978, 1980. Prerequisite: Electrical Engineering 203. One course. *Nolte*

**205. Signal Detection and Extraction Theory.** Introduction to signal detection and information extraction theory from a statistical decision theory viewpoint. Subject areas covered within the context of a digital environment are decision theory, detection, and estimation of known and random signals in noise, estimation of parameters and adaptive recursive digital filtering, and decision processes with finite memory. Applications to problems in communication theory. Spring semester. (Also listed as Computer Science 205.) Prerequisite: Electrical Engineering 203 or consent of instructor. One course. *Nolte*

**206. Digital Signal Processing.** Introduction to the fundamentals of processing signals by digital techniques with applications to practical problems. Discrete time signals and systems, elements of the z-transform, discrete Fourier transforms, digital filter design techniques, fast Fourier transforms, and discrete random signals. Spring semester. One course. *Nolte*

**208. Digital Computer Design.** Hardware implementation of combinational and sequential switching networks. Arithmetic elements, switching matrices, char-

acter generators, counters, and shift registers. Detailed design and simulation of a general-purpose computer system. Computer architectures based on macromodules, hardware compiler implementations, and parallel processing concepts are also discussed. Prerequisite: Electrical Engineering 157 or consent of instructor. Spring semester. (Also listed as Computer Science 208.) One course. *Marinos*

**211. Solid State Theory.** A treatment of postulatory quantum mechanics and statistical mechanics to serve as a background for the solid state sciences. Topics include both the Schrodinger and matrix formulations, angular momentum, perturbation methods, Maxwell-Boltzmann and Fermi distributions. Prerequisite: consent of instructor. Fall semester. One course. *Artley or Hacker*

**212. Solid State Materials.** Concepts of solid state physics as applied to engineering materials; electric magnetic, thermal, and mechanical properties of solids; dielectrics; semiconductors; magnetic materials; superconductors. Prerequisite: Electrical Engineering 211. Spring semester. One course. *Artley or Hacker*

**213. Principles of Magnetism.** A discussion of the various classes of magnetic materials including diamagnets, paramagnets, ferromagnets, antiferromagnets, and ferrimagnets. Typical topics include: crystal field effects, exchange interactions, domain formation, and resonance phenomena. Prerequisite: consent of instructor. One course. *Artley or Hacker*

**215. Semiconductor Physics.** A quantitative treatment of the physical processes that underlie semiconductor device operation. Topics include: band theory and conduction phenomena; equilibrium and nonequilibrium charge carrier distributions; charge generation, injection, and recombination; drift and diffusion processes. Prerequisite: Electrical Engineering 211 or consent of instructor. One course. *Hacker*

**217. Masers.** Principles of masers, particularly optical masers. Discussion of quantum electronics, optical configuration; solid state, gaseous, and liquid devices; modulation; high power operation. Prerequisite: consent of instructor. Some laboratory work. Spring semesters, 1977, 1979. One course. *George or Lontz*

**221. Nonlinear Networks and Systems.** Characterization of nonlinear multi-terminal network elements, formulation of system equations from topological and energy considerations. Basic properties and general methods of solution of resistive nonlinear networks. Time-varying linear systems. Examination of some fundamental properties of nonlinear differential equations. Spring semester. One course. *Wilson*

**222. Nonlinear Analysis.** Introduction to methods of analyzing engineering systems described by nonlinear differential equations: analytic, numerical, graphical, and series approximation methods; analysis of singular points; stability of nonlinear systems. Applications of various methods, such as the modified Euler, Runge-Kutta, isoclines, perturbation, reversion, variation of parameters, residuals, harmonic balance, Bendixon, and Liapounov to phenomena of nonlinear resonance, subharmonics, relaxation oscillations, and forced oscillating systems. Fall semester. (Also listed as Mechanical Engineering 322.) One course. *Wilson*

**224. Integrated Electronics: Analog and Digital.** Application of integrated circuits for analog and digital systems. Topics include the effect of fabrication techniques on circuitry design, a study of differential and operational amplifiers, and consideration of various logic families such as resistor-transistor logic (RTL), diode-transistor logic (DTL), current-mode or emitter-coupled logic (ECL), and transistor-

transistor logic (TTL). Prerequisite: Electrical Engineering 161 or equivalent. Fall semester. One course. *Wilson or Shubert*

**225. Semiconductor Electronic Circuits.** Analysis and design of electronic circuits utilizing a variety of static and dynamic models of semiconductor devices. Transistor and other semiconductor device circuit models; bias stability; high frequency and noise models; switching characteristics; illustrative semiconductor circuits. Selected laboratory work. Spring semester. Prerequisite: consent of instructor. One course. *Joines*

**227. Network Synthesis.** Linear network theory, including a review of time and frequency domain analysis; network graphs; network functions and realizability condition; driving point impedance synthesis of passive networks; driving point and transfer specifications; approximation methods. Fall semesters, 1977, 1979. Prerequisite: consent of instructor. One course. *George*

**241. Linear Systems.** Modeling of multiple input-output linear systems in the frequency and time domains. Matrix differential and difference equations and their solutions; state variables. Digital simulation of differential systems. Fourier analysis of signals and systems. Transform techniques applied to state variable models. State space models of distributed systems. Fall semester. One course. *Kerr or Wang*

**242. Modern Control and Dynamic Systems.** See course description for Mechanical Engineering 230. (Also listed as Mechanical Engineering 230.) One course. *Wright*

**243. Advanced Linear Systems Theory.** Linear spaces and linear operators. Impulse-response matrices. Controllability and observability. Irreducible realizations of rational transfer function matrices. Canonical forms, state estimators, and observer theory. Stability. Linear time-invariant composite systems. Prerequisite: Electrical Engineering 241. Spring semesters, 1978, 1980. One course. *Wang*

**251. Pattern Classification and Recognition.** Parameter estimation and supervised learning; nonparametric techniques; linear discriminant functions; clustering; language theory related to pattern recognition and syntactic pattern recognition; examples such as characters, severe weather recognition, and classification of community health data are discussed. Prerequisite: consent of instructor. Spring semesters, 1978, 1980. One course. *Wang*

**265. Advanced Topics in Electrical Engineering.** Opportunity for study of advanced subjects related to programs within the Electrical Engineering Department tailored to fit the requirements of a small group. Prerequisites: approval of the Director of Undergraduate Studies and of instructor under whom work will be done. One course. *Staff*

**266. Biofeedback Systems.** Instrumentation, on-line computer analysis, and models associated with biofeedback systems. Selected readings will be considered in conjunction with experience in laboratory feedback practices. The physical, physiological, and psychological aspects of biofeedback provide a vehicle for experiential learning which relates individual experience to models used in systems theory, field theory, electronics, and communications. Undergraduate electrical engineering majors may not use this course as one of their four electrical engineering elective courses. Prerequisite: consent of instructor. Spring semester. One course. *Artley*

**271. Electromagnetic Theory.** The classical theory of Maxwell's equations; electrostatics, magnetostatics, boundary value problems including numerical solu-



tions, currents and their interactions, and force and energy relations. Three class sessions. Fall semester. Prerequisite: consent of instructor. One course. *Joines*

**272. Application of Electromagnetic Theory.** Propagation of electromagnetic waves in various structures and media; mathematical description of microwave networks, including equivalent circuits and matrix methods; microwave circuit theorems and synthesis techniques. Selected laboratory experiments. Spring semesters, 1978, 1980. Prerequisite: Electrical Engineering 271. One course. *Joines*

### Departmental Major in Electrical Engineering

The major requirements are included in the minimum total of thirty-two courses listed under the general requirements and departmental requirements. The specific courses Electrical Engineering 63 and 113 must be included.

## MECHANICAL ENGINEERING AND MATERIALS SCIENCE

Professor Chaddock, *Chairman*; Associate Professor Shepard, *Director of Undergraduate Studies*; Professors Clark, Garg, Harman, Macduff, and Pearsall; Adjunct Professor Roberts; Associate Professors Cocks, Elsevier, and Wright; Adjunct Associate Professor Mayer; Assistant Professors Buzzard, Johnson, and Shaughnessy

In a modern technological society the profession of mechanical engineering has a three-fold role. The first and traditional role is the production of devices and machines. The products are as varied as the needs of mankind, from a mechanical toothpaste tube filler to a hydraulic turbine for harnessing tidal power or a home heating system powered by solar energy. The second role has gradually evolved from the first, and now encompasses in-depth technical analyses and the design of complex engineering systems. Examples are nuclear power stations and ocean habitats for undersea exploration. The third role involves the relationship between technological change and man's social, biological, and physical environment. It is no longer adequate to consider only obvious benefits and immediate costs; engineering solutions must be related to society's nontechnical needs and problems. If an educational program is to provide engineering leaders, it must respond to these broadening roles.

Historically, the available materials have limited the technological development of any age. The development of materials with particular combinations of mechanical, chemical, and electrical properties continues as a limiting step for technological advances on almost every engineering frontier. An especially crucial area requiring the skills of materials scientists and engineers is that of energy conversion. Needs exist not only in the overall production, distribution, and use of energy itself, but also in the development of less energy-consuming processes for the production of materials.

The undergraduate curriculum in mechanical engineering and materials science provides a broad base in the basic sciences and mathematics, engineering and materials sciences, analog and digital computation, mechanical design, systems theory, and engineering applications involving analysis, synthesis, and design. The search for viable solutions to mankind's problems also requires an engineer to interact with other professions and disciplines; to reach out for an understanding of the economic, social, health, and political consequences of engineering decisions. Elective opportunities in the social sciences, life sciences, and humanities help fill this need.

Undergraduate laboratories provide unique learning experiences and assist in the development of professional attitudes and approaches to typical engineering problems. In the System Dynamics Laboratory, fundamentals of instrumentation and dynamic responses are introduced through simulation techniques. The Materi-



als Laboratory has equipment for the synthesis and evaluation of metals, polymers, ceramics, and biomaterials. Experiments in the Fluid Mechanics and Heat Transfer Laboratories relate velocity and temperature field measurements to fluid friction and heat exchange processes. In the System Response and Control Laboratory, computer simulation of feedback systems and familiarization with automatic control of hydraulic and pneumatic components is emphasized.

Involvement with mechanical engineering and materials science goes beyond any specific technology, device, or system. Based on the curriculum, students will experience the ways in which scientific knowledge can be utilized in the design and development of useful devices and processes. With the curriculum flexibility and the variety of course offerings, students can choose courses of study most suited to their aptitudes.

**65. Introduction to Energy Technology.** The objectives of this course are to survey the whole field of energy conservation and control, and to stimulate the student into thinking creatively and inventively about energy technology. Topics to be covered include: the energy crisis; energy sources and uses; thermodynamics, engineering approaches to energy conversion, nuclear and fossil fuel power plants; new energy technologies including solar, geothermal, wind, and tidal; transportable energy sources and energy storage systems. Not open to junior and senior mechanical engineers. One course. *Chaddock, Cocks, Harman, and Shepard*

**102. Thermodynamics II.** Review of the laws of thermodynamics and some of their consequences relative to energy conversion. Statistical concepts of the second law. Properties of real gases, gas mixtures, and solids. Generalized thermodynamic relationships. Combustion, thermochemistry, and chemical equilibrium. Applications to combustion power cycles, propulsion, and heat pumping. Prerequisite: Mechanical Engineering 101. One course. *Elsevier*

**111. Physical Metallurgy.** Extension of the principles of Engineering 83 to the metallic state; atomic, experimental, and thermodynamic approaches to metallurgy; phase transformations and hardening mechanisms, relationships between the structure of alloys and plastic behavior with emphasis on engineering alloy systems. Prerequisite: Engineering 83. One course. *Cocks, Pearsall, or Shepard*

**112. Polymer Science.** Extension of the principles of Engineering 83 to high molecular weight polymers, especially those which have significant engineering applications; structure and properties of polymers; polymerization mechanisms; properties of commercial polymers; polymer processing. Prerequisite: Engineering 83. One course. *Clark or Pearsall*

**113. Materials Science and Energy Technology.** The limitations imposed by materials problems on the development of new energy technologies. Nuclear power and thermonuclear fusion, solar power, magnetohydrodynamics, fuel cells, superconducting electric power generators, and geothermal systems will be studied together with the materials limitations of magnetic, dielectric, mechanical, and gaseous fuel energy storage methods. The role of materials technology in increasing the efficiency of conventional conversion methods will also be included. Prerequisite: Engineering 83 or Mechanical Engineering 65. One course. *Cocks and Shepard*

**115. Failure Analysis and Prevention.** A study and analysis of the causes of failure in engineering materials and the diagnosis of those causes. Elimination of failures through proper material selection, treatment, and use. Case histories. Examination of fracture surfaces. Laboratory investigations of different failure mechanisms. Prerequisite: Engineering 83 or consent of instructor. One course. *Cocks or Shepard*

**123. Dynamics.** General principles of dynamics as applied to particles, rigid bodies, and selected nonrigid systems with emphasis on the formulation of engineering problems. Absolute and relative motion analysis. Work-energy and impulse-momentum methods. Introduction to kinematics and kinetics in three dimensions and to Lagrange's equations using generalized coordinates. Prerequisites: Physics 51, Mathematics 103, and Engineering 75. One course. *Macduff or Wright*

**126. Fluid Mechanics.** An introductory course emphasizing the application of the principles of conservation of mass, momentum, and energy to a fluid system. Physical properties of fluids; dimensional analysis and similitude, viscous effects and integral boundary layer theory; subsonic and supersonic flows; normal shock waves. Selected laboratory work. Corequisites: Mechanical Engineering 123 and 101. One course. *Shaughnessy*

**135. Vibration Control.** An introduction to the dynamics of mechanical systems; equilibrium, stability, and lumped and distributed systems. System analysis by classical differential equations, mechanical impedance, and computer methods. Prerequisites: Mathematics 103 and Engineering 72. One course. *Macduff*

**136. Response of Systems.** System design for optimum dynamic response. Development of mathematical models from physical systems, operational and computer techniques, matrix methods for lumped and distributed systems, instrumentation and testing of components and systems, effect of nonlinearities. Prerequisites: Mathematics 111, Mechanical Engineering 123, and Engineering 72. One course. *Macduff or Wright*

**141. Mechanical Design.** A study of the broad aspects of mechanical design starting with the creative process and considering the effects of economics, human factors, ethics, and prior art on design. Basic mechanical components such as gears, cams, bearings, springs, shafts, etc. will be introduced in the discussions so that the student will become familiar with their design and application. A term design project will serve to practice the application of the design process. Prerequisite: Mechanical Engineering 123. One course. *Linderoth or Roberts*

**142. Kinematics and Dynamics of Machinery.** Study of the geometry of mechanisms. An introduction to the mathematics of gears, cams, linkages, and intermittent motion devices. The kinematics of linkages. Computer solutions for linkage problems. Prerequisite: Mathematics 103. Corequisite: Engineering 123. One course.

**143. The Design of Machine Elements.** The detail design of machine elements. Study of the problems of stress and strain (deflections) as they affect and modify design requirements. Reliability and safety as design parameters. Prerequisite: Mechanical Engineering 141. One course.

**150. Heat and Mass Transfer.** A rigorous development of the laws of mass and energy transport as applied to a continuum. Energy transfer by conduction, in laminar and turbulent flow inside and outside of tubes, and by radiation. Application to heat exchangers, thermal power equipment, and heat transfer in the environment. Introduction to the principles of molecular diffusion and convective mass transfer. Use of the analogies between mass, momentum, and energy transfer in problem-solving. Selected laboratory work. Prerequisites: Mechanical Engineering 126 and Mathematics 111. One course. *Buzzard or Chaddock*

**153. Heating, Air Conditioning, and Refrigeration.** Principles of thermodynamics, heat transfer, and fluid flow applied to comfort and industrial air conditioning. Cycles and equipment for heating, cooling, and humidity control. Air

transmission and distribution. Modern vapor compression, absorption, and low temperature refrigeration cycles and systems. Prerequisite: Mechanical Engineering 101. One course. *Elsevier*

**156. Combustion Engines.** A study of cycles, fuels, and fuel mixtures in piston, ram jet, and rocket engines. Comparison of real and theoretical cycles; carburetion and fuel injection systems; and modern developments. Prerequisite: Mechanical Engineering 101. One course. *Elsevier*

**165, 166. Special Topics in Mechanical Engineering.** Study arranged on a special engineering topic in which the faculty has particular interest and competence as a result of research and professional activities. Prerequisites: consent of the instructor and the Director of Undergraduate Studies. Each half-course or one course. *Staff*

**177. Computer Techniques for Simulation and Design.** Optimization methods for engineering design. Unconstrained and constrained minimization procedures with linear programming shown as a special case of the gradient projection method. Computer solutions and design projects emphasized. One course. *Wright*

**183. Power Generation.** Basic concepts of thermodynamics, heat transfer, and fluid flow are applied to power generation processes. Steam power plants, both fossil fuel fired and nuclear reactor, are emphasized. Gas turbine, internal combustion engine, and combined cycles are included. Design and analysis includes economic and environmental consideration. One course. *Harman*

**197, 198. Projects in Mechanical Engineering.** This course may be assigned by the chairman of the department to outstanding seniors who express a desire for such work and who have shown aptitude for research in one distinct field of mechanical engineering. Prerequisites: *B* average and senior standing. Half-course to two courses. *Staff*

**202. Engineering Thermodynamics.** Review of classical thermodynamics. Thermodynamics of continuum properties of real substances. Analysis of energy conversion with internal irreversibility and advanced engineering problems. Introduction to the statistical basis of thermodynamics. One course. *Harman*

**209. Structural Dynamics.** (Also listed as Civil Engineering 209.) One course. *J. F. Wilson*

**210. Intermediate Dynamics.** Comprehensive treatment of space kinematics, kinetics of particles and rigid bodies; generalized coordinates and Lagrange's equations; introduction to stability and random dynamic analysis of flexible, continuous systems. (Also listed as Civil Engineering 210.) One course. *Macduff or J. F. Wilson*

**211. Theoretical and Applied Polymer Science.** An advanced course in materials science and engineering, dealing specifically with the structure and properties of polymers. Particular attention is paid to recent developments in the processing and use of modern plastics and fibers. Product design is considered in terms of polymer structures, processing techniques, and properties. One course. *Clark or Pearsall*

**213. Advanced Materials Science.** An in-depth study of current problems in materials applications conducted in a seminar format. Treatment will include thermal, electrical, optical, and magnetic properties of materials in terms of basic physical concepts. Subjects intended to provide materials scientists and engineers with a theoretical basis for understanding and manipulating properties. Prerequisites:



Engineering 83 and Mechanical Engineering 111 or 112. One course. *Cocks, Pearsall, or Shepard*

**214. Corrosion and Corrosion Control.** Effects of environments on the design and utilization of modern engineering alloys. Theory and mechanisms of corrosion, particularly in seawater and atmospheric environments. Microstructural aspects of diffusion, oxidation, hot corrosion, and stress corrosion. Prerequisite: Engineering 83. One course. *Cocks or Shepard*

**216. Materials Design and Resource Conservation.** The role of materials science and engineering in the field of resource conservation and recovery. Selection of materials for components of consumer products and equipment. Designing materials at atomic, molecular, and phase-structure levels to minimize energy consumption, optimize properties, and enhance recycling. Analysis of some constraints posed by thermodynamics, economics, raw material availability, and governmental policies. Prerequisite: Engineering 83. One course. *Pearsall*

**221. Compressible Fluid Flow.** Basic concepts of the flow of gases from the subsonic to the hypersonic regime. Effects of friction, heat transfer, and shock on one-dimensional inviscid flow. Potential theory, oblique shock waves, and special calculation techniques in two-dimensional flow. One course. *Harman*

**222. Heat Transfer.** Steady-state and transient solutions of the general heat conduction equation. Development of the equations for transport of energy by fluid motion. Principle of similarity and dimensional analysis in convective energy transport. Solutions of the boundary layer equations. The laws of radiation heat transfer and radiation heat exchange. One course. *Chaddock or Buzzard*

**223. Principles and Design of Heat Transfer Equipment.** Application of theoretical and experimental developments in heat transfer to the design of heat exchangers. Study of fin shapes, finned passages, fouling factors, baffling and other parameters of heat exchanger design. Analytical and numerical methods for design calculation illustrated with equipment, such as furnaces, recuperators, regenerators, solar collectors, condensers, evaporators. Prerequisite: Mechanical Engineering 150. One course. *Chaddock and Johnson*

**224. An Introduction to Turbulence.** Flow instability and the transition to turbulence. Physical characteristics of turbulent flows, averaging, and the Reynolds equation. Turbulent transport and mixing length theories. The statistical description of turbulence, correlations, and spectra. Fourier transforms. Measurement techniques. One course. *Shaughnessy*

**226. Intermediate Fluid Mechanics.** A survey of the principal concepts and equations of fluid mechanics. Fluid properties. Statics. Basic equations for the control volume. The differential equations of fluid motion. Stream function. Irrotational flow. Navier-Stokes equations. Kelvin's and Crocco's theorem. Applications to two-dimensional incompressible potential flow and to viscous flow in boundary layers. One course. *Shaughnessy*

**230. Modern Control and Dynamic Systems.** Dynamic modeling of complex linear and nonlinear physical systems involving the storage and transfer of matter and energy. Unified treatment of active and passive mechanical, electrical, and fluid systems. State space formulation of physical systems. Time and frequency-domain representation. Controllability and observability concepts. System response using analytical and computational techniques. Lyapunov method for system stability. Modification of system characteristics using feedback control and compensation. Introduction to optimal control using Euler-Lagrange and Pon-



tryagin's formulations. Emphasis on application of techniques to physical systems. (Also listed as Electrical Engineering 242.) One course. *Garg or Wright*

**231. Systems Response and Control.** Methods, applicable to design, of obtaining parameters for strength, response, and stability studies to mechanical systems. Analysis of closed loop control systems with linear transfer functions; electrical and mechanical analogs; introduction to determination of transfer function from input-output characteristics. One course. *Macduff or Wright*

**232. Nonlinear Analysis.** Fall semesters. Prerequisite: consent of instructor. (Also listed as Electrical Engineering 222.) One course. *T. Wilson*

**233. Fluid Control Systems.** A design-oriented course concerned with hydraulic and pneumatic feedback control systems. Basic control system characteristics; linearized transfer functions; determination of transfer function from computation and experiment; position, velocity, and acceleration feedback devices; transducers; d.c. and a.c. hydraulic and pneumatic amplifiers. One course. *Macduff*

**235. Advanced Mechanical Vibrations.** Analytical and experimental procedures applied to design of machines and systems for adequate vibration control. Determination of eigenvalues and eigenvectors by iteration and computer techniques; transfer matrices applied to lumped and distributed systems; analytical and numerical methods of obtaining the pulse response of plane and three dimensional multi-mass systems; convolution and data processing; introduction to random vibration. One course. *Macduff*

**236. Engineering Acoustics and Noise Control.** Specification of the physical properties of noise, noise measurement, and absorption, transmission, and propagation of sound. Effects of noise on man, noise exposure, and damage risk criteria. Legal aspects of noise control, source modification, enclosures, barriers, and personnel protectors. Prerequisites: Mechanical Engineering 123 and Mathematics 111. One course. *Macduff*

**251. Refrigeration and Cryogenics.** Theory and experiment in the evaluation of the thermodynamic properties of refrigerants and cryogenic fluids. Thermodynamics of vapor compression, air cycle, absorption, and thermoelectric refrigeration. Production of low and very low temperatures, helium liquefiers. Two-phase flow processes. Heat exchange for refrigeration and cryogenic transfer. One course. *Chaddock*

**255. Energy Conversion.** Principles, thermodynamics, and classification of energy conversion devices. Introduction to semiconductors, thermoelectric generators, photovoltaic generators, thermionic generators, magnetohydrodynamic generators, fuel cells, and other energy conversion devices. One course. *Harman*

**265. Advanced Topics in Mechanical Engineering.** Opportunity for study of advanced subjects related to programs within mechanical engineering tailored to fit the requirements of a small group. Prerequisites: approval of the Director of Undergraduate or Graduate Studies and the instructor under whom work will be done. One course. *Staff*

**273. Ocean Engineering.** Application of classical engineering disciplines to components and systems operating in the marine environment. Topics include marine corrosion, hydrodynamics and stability of vessels, marine power systems, man-rated pressure vessel and submersible design. Engineering concepts applied to the physiology and mechanics of diving, and marine-related energy resources. Prerequisite: Engineering 101 or equivalent. *Johnson*

**280. Nuclear Reactor Power Cycles.** Basic reactor principles and types. Examination of most feasible thermodynamic cycles for use with both stationary and mobile power plants. Consideration of safety shielding, heat transfer, fluid flow, and materials problems unique to reactor design. One course.

#### **Departmental Major in Mechanical Engineering and Materials Science**

The major requirements are included in the minimum total of thirty-two courses listed under the general requirements and departmental requirements. Specific courses which must be included are Engineering 72, 75, 83, and 101; Mechanical Engineering 123, 126, 136, 141, and 150.

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